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S&T Policy, New Directions

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State Science Commission S&T White Paper

91P60039a Beijing KEJI RIBAO [SCIENCE & TECHNOLOGY DAILY] in Chinese 18 Oct 90 p 1

[Article by Han Yuqi [7281 3768 3825]]

[Summary] In 1986, the State Science Commission released the first "Chinese Science and Technology Guidebook" or "Chinese Science and Technology White Paper" in order to disseminate Chinese S&T policy and to provide guidance to millions of S&T personnel [See JPRS-CST-87-013, 2 April 1987, for full translation]. This white paper presented systematically the Chinese government's significant policy and strategy decisions, related materials, and regulations for scientists and economists to supervise the national S&T activities. Four volumes of S&T white papers have been published since 1986 under the auspices of the Chinese government.

The white papers are significant because they demonstrate the nation's strong will to lead Chinese science and technology into a new international arena. The first S&T white paper outlined the fundamental strategy of Chinese S&T development and stressed the idea of constructing a national economy based on science and technology. The first white paper also reviewed Chinese S&T development during the period from 1949 to 1985, and gathered and clarified the main idea of Chinese S&T development policy. The first white paper was the first book to publish the technological key points of areas in energy, transportation, telecommunications, agriculture, consumer goods industry, machine industry, material industry, construction material industry, urban and rural construction, urban and suburban residential construction and environmental protection, and was the first book to cover data from S&T census in 1985. Later on, a new subject, "Soft Science Study", was added to the No 2 issue; another two subjects, "Promulgation and Implementation of Technological Policy" and "Study on Major Policy Problems", were put into the No 3 issue. The recent (No 4) issue covers the entire Chinese S&T policy and the important documents published in 1989 and 1990, and highlights S&T system reform, S&T legislation, soft science study, S&T research and development, environment and resources, comparative analysis of Chinese S&T strength and a statistical index.

Long-Range Prospects for Sino-Soviet S&T Cooperation

90FE0308C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 18 Jun 90 p 7

[Article by Liu Baorong [0491 1405 2837]]

[Text] Not long ago, Premier Li Peng made an official visit to the Soviet Union and the two governments signed six agreements; one of these agreements is the "Long-Term Economic and Scientific Cooperation Agreement Between the People's Republic of China and the Union of Soviet Socialist Republics." This agreement has opened up a new prospect for economic and technological cooperation between the two countries.

In today's world, international cooperation is deepening, production is becoming more international and regional economic development is moving forward. The wave of technological revolution changes the structure of international commodity trade and increases the makeup of industrial products. This trend of development requires economic and technological cooperation between countries. The economic development in the Sino-Soviet relationship to date has relied mostly upon growth in trade. Experience tells us that, with large-scale increases in trade, the simple commodity exchange can no longer satisfy the needs of the new economic situation. To make the transition from mere commodity exchange to an economic relationship that includes cooperation in production and services as well, the two countries should build a mutually beneficial cooperation in science, technology, production and sales by developing a variety of types of economic and technological investment cooperation.

China and the Soviet Union are two neighboring countries, both with rich natural resources. The economy of the two countries each has its own unique features and advantages. The Soviet Union has a strong base in energy and more advanced materials and machine-building industry; the transportation industry in the Soviet Union is also quite strong. China has advantages in agriculture, light textiles, electronics, food processing, medicine and service industries. The economic and technological conditions of the two countries are complementary.

There have been encouraging developments in Sino-Soviet economic and technological cooperation. These developments are described below.

Economic and Technological Cooperation Has Been Extended Into New Areas

Although China and the Soviet Union signed an economic and technological cooperation agreement, and a science and technological cooperation agreement in the mid-1980's, the economic and technological cooperation between the two countries up to 1988 has been limited to power, metallurgy and textiles. In the second half of 1988, the pace picked up and the cooperation was extended to nonferrous metals, the petrochemical industry, natural gas, agriculture, transportation and health.

The Modes of Cooperation Have Increased

Based on the agreement for "Construction and Remodeling in China," China and the Soviet Union cooperated on new construction and remodeling projects. In addition, regions along the border have cooperated in manufacturing, joint production, jointly funded business, contracted engineering, forest harvesting, vegetable planting and building construction. Contracts currently

being implemented include the railroad from Wusu, Xinjiang to Ala pass (in the form of a commodity loan) and the import of Soviet power stations by the Chinese Huaneng Company by way of a commercial loan. The Huaneng Company will organize the repair of Soviet ships in China as a compensation for the Soviet equipment and services. These cooperative projects combine loans with local investment and make use of the complementary technical abilities of the two sides; it is a promising mode of cooperation.

Joint Enterprises Are Being Developed at a Fast Pace

In June 1988 the Chinese government and the Soviet government signed an agreement on the "establishment of joint enterprises and principles for their activity," this agreement provided a legal basis for cooperation in joint enterprises. In the last two years, a number of local agreements have been signed by the two sides to establish joint businesses inside the Soviet Union. The agreements involve light industry, building materials, health and medicine, and food services. Officially open for business are the Beijing Restaurant in Moscow, the Harbin Restaurant in Khabarovsk, and the color photography store in Bogelanich (?). Joint businesses that are taking shape include the joint enterprises "Tashkent International Thermos Bottle Company" and the "Akbrak Thermos Bottle Company" by Xinjiang and the Soviet Union. Today, the local authorities of the two countries are investigating the possibilities for joint ventures. This effort is progressing fairly quickly, but has also encountered a number of problems such as the balance of free foreign exchange in the joint business and the way the profits are transferred (by commodity or by cash).

As the mode of trade between the two countries changes, the importance of economic and technological cooperation is becoming more evident. Local cooperation will be an important avenue in Sino-Soviet economic and technological cooperation. A new situation in the cooperation can be expected.

Reform and Protecting S&T Secrets

90FE0240B Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 12, No 6, Jun 90 pp 32-33

[Article by Zhao Xiangwei [6392 4382 0251]: "Reform, the Open Policy, and Protecting S&T Secrets"]

[Text]

New Characteristics Under the New Situation

Science and technology is developing by leaps and bounds in the world to date, having penetrated every facet of modern society. S&T progress has become an important factor in determining a nation's military, economic, and social developments. In a certain sense, the rise and fall of a nation or a group is mainly shaped by its S&T development level. Whoever controls a piece of new technology first will corner the international market, has a leg up on its competition, and turn a technical advantage into a market advantage. Given the ferocious international competition, therefore, all nations seek to protect their S&T achievements and take pains to collect the S&T secrets of other countries even as they scramble to develop their own S&T. S&T espionage is ever on the rise. According to studies by foreign counter-intelligence experts, the number of intelligence agents involved in economic, technical, industrial, and commercial espionage on an international level, who resort to every modern technology, has exceeded that of their counterparts in political and military espionage and resort every more advanced technology. The international war between the stealing of secrets and efforts to prevent it is becoming increasingly fierce and complex.

As an intellectual commodity, S&T is highly confidential. A new S&T achievement is the crystallization of enormous amounts of human, material, and financial resources as well as time. If we do not do more to keep our S&T achievements secret, they may fall into the hands of another country, which will then have it patented ahead of us and research and develop a new product, thereby in one stroke turning itself into a leading contender on the international marketplace to compete with the original owner of the piece of technology in question. Alternatively, we may end up simply giving away S&T achievements with export value to another country, causing the economy unjustifiable losses.

Science and technology is a major engine of China's drive to move its economy to a new stage of growth as well as a precious national asset. Since China adopted an open policy, many of its industrial products have made their way into the international market and a host of new S&T achievements has been transferred to other nations. International technical trade was launched to earn foreign exchange. Like political, military, and economic secrets, S&T secrets are an important part of state secrets. Keeping S&T secrets is a major issue with an impact on national security and interests. It has growing importance in the overall task of protecting state secrets.

After China adopted an open policy, there have been new changes in the protection of S&T secrets. As a developing nation, China still trails the advanced countries in the world in the overall level of S&T. In its 4 decades of existence, particularly since the 3d Plenum of the 11th CPC Central Committee, however, new China has made almost 1,000 inventions, many of them meeting or surpassing the advanced level in the world. China has many traditional technologies and a wealth of know-how that are unique in the world, all of them worthy of classification. This shows that there is room for a classification system in China's S&T. As reform and the open policy went under way, S&T cooperation and exchange activities with the outside world have been increasing steadily, expanding both in scope and in depth. While this has powerfully driven China's socialist

construction, it has also objectively given foreign intelligence agents more opportunities to steal the nation's S&T secrets. Through a variety of channels, they try to steal China's ST& secrets in a thousand and one ways. Clearly this has made S&T secret protection that much more difficult and complex. On the one hand, we must adhere to the overall policy of reform and openness. On the other hand, we must step up protection work. Such is the new situation confronting us in the area of S&T secret protection. History entrusts two tasks to S&T secret protection in the new era: "protect" and "promote." To begin with, we must heighten our vigilance and diligently prevent the theft of our S&T secrets by alien forces. Next, S&T classification work must benefit the implementation of reform and the open policy, facilitate all kinds of undertakings, promote international cooperation and exchanges, and steadfastly serve the four socialist modernizations.

Major Avenues for the Leaking of Secrets

Nowadays, for a variety of reasons, state secrets of a S&T nature are frequently leaked through a multitude of channels, which can be summarized as follows:

1. Publicity and reporting. According to accounts in the foreign press, about 15 percent of intelligence gathered by a nation is supplied by its intelligence agents, 35 percent comes from modern electronic technology, and 50 percent is culled from publicity materials and reports available to the public. All intelligence agents in the world gather intelligence from such vehicles of information as newspapers, books, video tapes, and computer software as well as the mass media, including the radio and television.

2. Secrets may be leaked during international visits and study missions. In receiving foreigners who come to China to visit or on a study mission, we may divulge a technical secret inadvertently because of uncertainty as to which piece of S&T information should be kept secret and which may be publicly disclosed. The other party can gain access to secret technology by taking photographs or videotaping, even through a conversation. Some take advantage of the opportunity to visit or do interviews to request useful raw materials and important resources, clues to unraveling a technological secret.

3. Secrets may be leaked when one goes abroad to lecture or pursue advanced studies. Most of the people invited to lecture or make academic presentations overseas or selected to pursue advanced studies abroad are S&T personnel with solid academic accomplishments or a good deal of promise. In some cases, the new technology or applied theories they have mastered reach or exceed the highest levels in the world; in other instance, they are part of the motherland's traditional technology and know-how, all worthy of being kept secret. When they are invited abroad to lecture, some people are only too ready to divulge the pertinent S&T data as fully and in as much detail as possible, revealing every bit of the technology that should be kept secret, which often leads to the leaking of a secret. In recent years,it is not unheard of for people going overseas for advanced studies to take with them all the materials and samples on a major state project.

4. Secrets are leaked in the course of S&T cooperation and exchanges. Uninformed about S&T secret classification, patenting, and international technical trade, overeager to make a deal, and anxious to earn a fast buck, we put ourselves in a passive situation in foreign S&T and economic cooperation and exchange and in joint business ventures. Even worse, some people give away technical secrets, production costs, and production capacity to the other party even before an agreement is reached. As a result, the opponent becomes privy to our secrets, the negotiations fail, and we suffer economic losses.

5. Secrets are deliberately leaked in violation of state laws and regulations. Some secrets are leaked by mistake and some are leaked on purpose. Some individuals, putting profits before principle or morally degenerate, supply foreigners with S&T intelligence. Others, blinded by greed or for a particular reason, offer state S&T secrets for sale in gross violation of the classification law of the land.

Things That Must Be Done To Tighten S&T Secrecy

To make S&T secrets leak-proof involves the management of all units and sectors. Essentially we must do four things properly:

1. Formulate good and comprehensive laws and regulations. Secret classification legislation is a need of socialist modernization. The "Law of the PRC for Protecting State Secrets," examined and approved by the third meeting of the standing committee of the Seventh NPC, was formally promulgated on 5 September 1988 and went into effect on 1 May 1989. It is a major piece of legislation that is informed with the spirit of reform and is compatible with reform and the open policy. It also tightens the protection of state secrets. The "law" stipulates explicitly that state S&T secrets are an important part of state secrets. It provides for the punishment of individuals who leak state secrets either inadvertently or deliberately, from administrative disciplinary measures to being held criminally liable, depending on the seriousness of the case. It strengthens the protection of S&T secrets with the help of the law.

2. Publicity and education. While there are many reasons behind the leaking of S&T secrets, they all boil down to ideological numbness and a weak sense of protecting state secrets. Some people think, erroneously, that "there are no secrets to be kept" or that "it is hard to keep secrets." Often they cannot recognize a secret when they see one or fail to keep it when they do recognize one, thus consciously or unconsciously giving away state secrets. Compared to protecting political, economic, and diplomatic secrets, protecting S&T secrets has its own characteristics. A large quantity of S&T knowledge exists in a tangible form in books, publications, and data bases, but much exists in a nonmaterial form, namely, in a person's

head. Many applied technologies and know-how that can be turned into applied technology sometimes cannot be found in the files but in a person's head. For S&T secret protection to work, we must also operate at the ideological level. Legislation is the foundation of strengthening such protection; nothing will work if we have no laws to follow. Yet the existence of a law does not mean its compliance. Accordingly, while we must start out with good and comprehensive laws and regulations, we must also implement the principle of prevention, intensify ideological education, and make the law work even more effectively. State secret protection should be included in education in patriotism and in foreign-affairs discipline. Ideological education should aim at making people vigilant all the time. It should integrate reality and can be made lively and diversified in form, with the emphasis on practical results.

3. S&T classification. "The Law for Protecting State Secrets" explicitly provides for a three-fold classification of state secrets: top secret, secret, and classified. Not all science and technology belongs to the realm of state secrets. S&T classification means assigning a piece of technology to either one of the three levels of secrecy in accordance with the "Detailed Scope of State Secrets and Secrecy Classification" and "Methods for Assessing Secrecy Classification." It is the basis of and a prerequisite for successfully protecting S&T secrets. The key to S&T classification is accuracy. Practice proves that classification in strict accordance with the "Legal Procedures" of the "Law for Protecting State Secrets" and established evaluation methods and with help from S&T experts is the basic principle of ensuring that S&T classification is scientific and non-arbitrary.

4. Handle three relationships properly: 1) The relationship between protecting state secrets and cooperation and exchange. Economic development in any country cannot isolate itself from international S&T cooperation and exchange. Cooperation and exchange suggest contacts. If everything is classified top secret and kept out of bounds, we would not be able to learn advanced foreign technology or management. We would be like a person who refrains from eating for fear of choking. The economic and social benefits resulting from reform and the open policy in China have attracted worldwide attention. Reform must be continued steadfastly as in the past. But even as we engage in S&T cooperation and exchange, we must adhere to the principle of equality and mutual benefit and safeguard state secrets unwaveringly to ensure that national security and interests are not compromised. 2) The relationship between secrecy and friendship. It is well and good to be friendly with a nation, but we must still keep secrets secret. This is entirely consistent with international practices. As we make friends with other countries, we must be strictly on guard against ideological numbness and not forget protecting S&T secrets. Our ideological similarities to or differences from another nation and the extent of our friendship with it are irrelevant to the protection of state secrets. Let us cooperate and conduct exchanges with other nations conditionally in accordance with the principle of equality and mutual benefit, with each party playing its role. In so doing, we are already being friendly. It is a mistake to think that "if you are friendly with a nation, you cannot keep secrets from it because to do so would affect the friendship." 3) The relationship between protecting state secrets and the open policy. The protection of S&T secrets mainly concerns itself with the examination and screening of applied technology, technical imports and exports, technology to be put on display in exhibitions, personnel going abroad to visit, and the publications of papers. In essence, however, protecting S&T secrets means the correct handling of the relationship between protecting secrets and openness. In light of the guiding thought behind the protection of S&T secrets in the new era, I believe both openness and the protection of S&T secrets are means to achieving the four socialist modernizations. The two are supplementary. They both serve and are subordinate to China's socialist modernization. On this point there is no inconsistency between protecting S&T secrets and the open policy.

Objectives of '863' Program in Eighth 5-Year Period Listed

91FE0110B Tianjin ZHONGGUO JISHU SHICHANG BAO [CHINA TECHNOLOGY MARKET NEWS] in Chinese 6 Oct 90 p 1

[Article: "Magnificent Goals for '863' Plan During Eighth 5-Year Plan, Breakthroughs Attempted in High Technology and Key Technology Realms"]

[Text] The State Science and Technology Commission has stated that obvious achievements have been made in the 3-plus years since China implemented a high technology research and development plan (known as the "863 Plan"). Plans in five realms arranged 95 topical projects, of which 45 projects call for producing experimental prototypes, target products, or major stage achievements, 37 projects may make breakthroughs in key technologies, complete laboratory research, produce performance prototypes, or enter intermediate testing, and 13 projects will track the leading edge of high tech and reduce our lag behind advanced world levels. Concrete goals were set forth for biotechnology, information technology, automation technology, energy resource technology, new materials, and other areas.

Biotechnology. Breed paddy rice combinations which can increase unit output by 20 percent over existing three-series method hybrid paddy rice. Increase the symbiotic nitrogen-fixing and combined nitrogen-fixing capabilities of paddy rice and other main crops. Breed several new varieties of high output, superior quality, and regression (disease)-resistant animals and plants. Develop biological products that can effectively prevent hepatitis-B and other main infectious diseases in China, biological products for malignant tumors and cardiovascular diseases, and gradually form a new biotechnology industry with Chinese characteristics. Utilize protein engineering technologies to transform and create enzymes and proteins with major medical and industrial value and make their structure and performance superior than natural products. Attain current international levels in the biotechnology realm and incisive technology areas, and make innovations and attain vanguard status in some technologies.

Information technology. Make breakthrough advances in intelligent technology applications, development of optical communications technology, and other areas and track international developments in intensive technological research. In the area of language input and differentiation in Chinese language computers, we should complete differentiation between characters with similar sounds and attain advanced international levels in differentiating unknowns and information compression technologies for special conditions. Complete first-level and second-level Chinese character differentiation in the area of model differentiation of handwritten Chinese character input and form a set of unique and convenient to use Chinese language computer systems in conjunction with Chinese character input and place them on the market. Complete development of 622 megabit integrated optical terminals and form a yearly production capacity of 10,000 units. Link together closely with the main battlefields, provide basic and support conditions for the development of optical communication systems in China during the Eighth 5-Year Plan. In the area of information collection and processing technology, we should gain an understanding of new high speed and high precision information collection and real-time graphic processing technology, promote breakthroughs in the area of their applications, and in particular make substantial progress in developing satellite-carried synthetic aperture radar and infrared focal plane technology.

Automation technology. Track and study key technologies for computer comprehensive automated manufacturing systems, complete the establishment of a demonstration production line at Qinghua University, gradually extend CIMS technologies, provide integrated technology for plant automation, and play a leading role in technical transformation of traditional industry. Develop principle prototypes for the five different categories of intelligent robots for precision work, work at water depths greater than 300 meters, work in terrible environments, and so on, develop engineering prototypes, provide key technologies, and take a major step forward in tracking international developments.

Energy resource technology. Complete technical designs for 10 MW grade coal-fired combined MHD-steam pilot power plants and do laboratory design for the primary equipment. Do R&D on the type of reactor with the best performance for each of the three types of fast neutron breeder reactors, high-temperature gas-cooled reactors, and fission-fusion reactors. Complete designs and experimental research for the 10 MW high-temperature gas-cooled experimental reactor, 25 MW experimental fast reactor, and compound reactor power core simulation devices.

New materials. Develop and explore high-level materials for developing information technology in the 21st Century, develop high temperature-resistant, shock-resistant, and highly malleable composite materials for power equipment, and develop corrosion-resistant and lightweight structural materials for aerospace equipment. We also should explore materials design and development as well as applied techniques and technologies under guidance by different levels of microstructural theory. We should make breakthroughs in key technologies used in thermoplastic resin base composite materials techniques. The main performance indices of metallic base composite materials should approximate or reach foreign levels of the mid-1980's, and we should strengthen research on ceramic-base composite materials. We should develop semiconductor photoelectric materials and optical memory materials, and their performance should approximate or reach foreign levels of the late 1980's. We should try to make breakthroughs in artificial crystal processing, inspection, and component development and continue to maintain vanguard international levels.

National Key S&T Task Plans Outlined

91FE0110A Tianjin ZHONGGUO JISHU SHICHANG BAO [CHINA TECHNOLOGY MARKET NEWS] in Chinese 3 Oct 90 p 1

[Article: "Magnificent and Stable Plans To Attack Key State S&T Problems During Eighth 5-Year Plan, Simultaneous Work on Agriculture, Basic Industry, Emerging Technology, and Social Development"]

[Text] The State Science and Technology Commission has stated that proposals concerning plans to attack key state S&T problems during the Eighth 5-Year Plan indicate that 60 projects and 250 topics have been selected in the four areas of agriculture, basic industry, emerging technology, and social development. The focus is on projects to support agriculture, large equipment development, energy resources, communications, primary raw materials, and in the areas mentioned above related to emerging technology, social development, and so on.

In the area of agriculture and agriculture-support industry, the proposals call for efforts to increase unit output, improve quality, and increase input/output ratios and focus on breeding improved varieties, comprehensive improvement in moderate and low output regions, and grasslands construction. Take full advantage of our abundant germplasm resources and study more than 200 new high output, stable output, superior quality, and multi-resistant crop varieties to replace China's grain, cotton, oil crop, vegetable, and other primary crop varieties, increase output by 10 to 15 percent, and extend them on 100 million mu of demonstration plots. Study rational technical structures, resource structures, ecological structures, and economic structures for achieving agricultural modernization on the Huang-Huai Plain, San Jiang-Songnen Plain, red and yellow soil hilly regions of south China, arid land in north China, the loess plateau, and other moderate and low output regions, establish the corresponding optimized technology systems, and provide a scientific foundation for coordinated development of cropping, breeding, and processing industries. Study techniques for improving grassland desertification and reversion, establish demonstration and experiment regions in north China to raise the livestock carrying capacity of China's pastures from the present level of 5 heads per 100 mu to 15 heads. Industries which support agriculture such as chemical fertilizers, pesticides, and so on should focus on R&D for compound feeds and on developing high efficiency, low toxicity, and low residual antibiotics and herbicides and on farm chemical intermediates, strengthen research on pesticide manufacturing technologies, and regarding agricultural film, focus on easily spread and easily recovered ground film.

In the area of attacks on key S&T problems in industry, proposals call for solving key technologies in the following areas: 1) Assimilating and shifting to domestic development of large imported sets of technology and equipment for energy resources, communications, and raw materials in conjunction with the second phase project at Qinshan to gain an understanding of large scale nuclear power plant technology focused on 600 MW pressurized water reactor series, development of oil field drilling and extraction equipment suitable for use in marine, shallow sea, and desert regions in China, sets of equipment for road surface construction of high-grade highways, and so on, and continue to focus on development of the 11 sets of equipment transferred from the Seventh 5-Year Plan. 2) Development and utilization of important new technologies for conserving energy, reducing consumption, and increasing output, adoption of new blast furnace oxygen and coal iron smelting technologies, continuous casting and direct rolling technologies for thin plates and blanks, development and utilization of new techniques and equipment for aluminum smelting, AC-DC-AC energy powered electric locomotives, organization of new technologies for intensive processing of heavy oil, and so on. 3) Development of important new products that conserve foreign exchange and generate foreign exchange. We should reinforce research on modifying common plastics and on plastic alloying and form a definite scale focused on developing common engineering plastics and new types of engineering plastics, and develop substitutes for imported high efficiency plastic catalysts. Light and textile products should focus on increasing the added value of products and increasing product varieties, improving competitiveness in international markets, and focus on developing new varieties of dyes to eliminate the long term situation in the past of relying on imports. 4) Resource surveys and comprehensive resource utilization technologies. We should clarify the geological conditions for the formation of large gas deposits and laws of natural gas accumulation in Tarim, Jungar, Ordos, and Sichuan basins and in the Qiongdongnan-Yingge Hai and East China Sea basins, do research on effective survey technologies for locating valuable metal ore resources, continue to arrange comprehensive utilization technologies for resources at Jinchuan, Baotou, Panzhihua, and other areas, and organize attacks on key problems in tungsten resources and associated resources.

Proposals in the area of emerging technologies: on the basis of work in the Seventh 5-Year Plan, we should perfect and optimize 3 micrometer production techniques, do research on 1 micrometer and submicrometer techniques and technologies, and develop special-purpose integrated circuits. For computer technology and software, focus on industrialized production technologies for 32-bit microcomputers and the five types of matching peripherals, develop huge, large, and medium-size computer systems, and develop several types of support software and software tools. For communications technology, promote application of four-subgroup optical communications and undertake research on five-subgroup optical communications, comprehensive professional digital networks, digital microwave and cellular mobile communications, and other

technologies. For automation technologies, focus on large piers, large kilns, and multiphase complex system control technology for the chemical industry, develop high performance, hydraulic, and pneumatic components and electrical and electronics components, and gain an understanding of high performance sensor design and manufacturing technologies. In the area of biotechnology, the key tasks are to serve agriculture, medicine, and light industry, and to utilize cell engineering, genetic engineering, enzyme engineering, and fermentation engineering to replace traditional production arrangements. For new materials, the focus is on technical transformation of the energy resource, communications, and raw materials industries, and R&D on several special purpose-materials, compound materials, membrane materials, non-crystalline state materials, and superconducting materials for the electronics and military industries to meet the needs of electromechanical industry development and national defense construction.

In the area of using S&T to promote social development, the focus is on population control, medicine, and public health, the ecological environment, preventing natural disasters, and safe production. Proposals call for developing new birth control methods, intensive research on pathogeny, mechanisms of disease incidence, and prevention methods to make an obvious decrease in death rates from malignant tumors and cardiovascular disease and the incidence of viral hepatitis and endemical and occupational diseases. Typical regions with serious pollution will be selected for the goal of controlling total amounts of the three wastes [waste gas, waste water, and industrial residues] and on comprehensive control technologies for converting the three wastes into resources to make definite improvements in China's environmental quality. We should study professional techniques for long-term atmospheric forecasting and gain an understanding of monitoring and forecasting of hazardous weather, establish a set of effective disaster assessment and forecasting methods, study techniques for preventing and controlling serious terrible accidents and the repeated occurrence of accidents, and form a preliminary safe production environment. We also should reinforce research on comprehensive control and development of the Chang Jiang and Huang He river basins and suggest comprehensive control programs and measures for the Chang Jiang and Huang He.

Measures for Selecting Key S&T Projects in the Eighth 5-Year Plan

90FE0290B Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 3, May 90 pp 1-2, 34

[Article by Jiang Junlu [1203 0971 7216] of the Office of Science and Technology, State Planning Commission: "Selecting and Appraising Projects To Attack Key S&T Problems in the Eighth 5-Year Plan"]

[Text] **Abstract**

This article concerns project application and establishment principles for projects to attack key S&T problems during the Eighth 5-Year Plan, assessment and examination work, rolling implementation, and other issues in conjunction with a brief description of the spirit of related state policies. Finally, it suggests certain questions that should receive attention in work methods.

Many units, ministries, commissions, and provincial and municipal departments concerned with S&T management which were responsible for state projects to attack key S&T problems during the Seventh 5-Year Plan and new units and new organs which hope to apply for projects to attack key S&T problems during the Eighth 5-Year Plan are extremely concerned with attacks on key S&T problems in the Eighth 5-Year Plan. Some are already doing considerable preparatory work, some are actively clearing channels, some are now organizing staffs to reinforce horizontal integration, and so on. It should be said that work in this area is now moving in steps from "discussing principles" to "dealing with concrete matters relating to work." At this time, the question of ways to make work more effective is consistently a major issue in the minds of people in all related areas. I am offering some views for joint discussion by everyone:

A. Project establishment principles for selecting and applying for projects to attack key S&T problems during the Eighth 5-Year Plan. Rather clear descriptions have been made in the relevant S&T documents from the Office of Science and Technology in the State Planning Commission. To facilitate exchange and provide a more extensive understanding, they can be summarized in four words: "required, advanced, feasible, beneficial."

1. Required: First of all, we should be concerned with major S&T problems whose solutions are urgently required for national economic construction and social progress in China over the next 5 to 10 years. These problems must be solved within 3 to 5 years and used in national economic construction. For example, to solve the food and clothing problems of 1.1 billion people, we should resolutely do systematic and comprehensive research on agricultural S&T problems like breeding improved varieties, water conservation, cropping, plant protection, fertilization, and so on. We must work hard to reinforce electronic technology to achieve the four modernizations drive. This mainly involves research on information electronics technology, electrical and electronics technology, sensor electronics technology, and so on. In summary, we should begin with real key technical problems faced by national economic construction, which means guiding and promoting technical development and scientific research according to China's economic construction, social development, and market demand.

2. Advanced: In technical levels, they should at least be scientific research projects which are at the vanguard in China or are completely absent and urgently needed in China at the present time. We should take full advantage

of China's talented personnel and resources, do innovative research, and try to overcome technical problems to attain world levels of the mid-1980's. They should embody an important characteristic of modern S&T development: interpermeation and interaction of all scientific disciplines. Simply relying on single technical breakthroughs is insufficient. We must rely on organic integration of multiple interrelated technical innovations before we can overcome problems with applied technology. Examples include research on comprehensive and highly effective utilization of China's abundant coal resources to reinforce single-carbon chemistry, the specific slants required in the area of research on nuclear technology for Eighth 5-Year Plan projects to rationalize our energy resource structure, and research on new fluidized bed technologies and techniques with broad applications in the combustion, cement, chemical, pharmaceutical, and other industries. To develop and extend projects with major characteristics, we should use the mechanism of market regulation to open up and invigorate the atmosphere and relax controls to allow the large numbers of S&T personnel in basic-level units to "orient toward the economy" and do research on extension and application.

3. Feasible: This mainly refers to manpower, finances, and materials implementation conditions. There must be a solid and organized staff to attack key S&T problems and acknowledged disciplinary leaders. Scientific research subsidies, operating expenses for personnel taking on projects, normal operating expenses for scientific research, and all other primary investments should be implemented or the related channels opened up. The primary key instruments and equipment, external support conditions for scientific research work, and other material foundations for laboratories should have already attained or nearly attained levels to undertake research on key problems.

Modern scientific research is becoming more difficult and larger in scale. It is developing from single technical innovations to sets of technical innovations. Many scientific research projects cannot be completed independently by simply relying on one department or a single research academy or institute. For this reason, many units or groups must do cooperative research to complete several major scientific research projects. Although the government is the main source of investments for major S&T research projects at the state level, actual implementation of the projects must depend on major support from administrative departments at all levels in the areas of manpower, finances, and materials and rely on technology, personnel, and basic conditions accumulated over the long term in responsible units. Future practice will confirm that actively creating the conditions is essential for smoothly using bid solicitation (or assignment by assessment and examination committees in some cases) to take on tasks to attack key problems.

4. Beneficial: The benefits referred to here are mainly an ability to interlink organically with plans for technical transformation, capital construction, and social development to make S&T the primary motive force in economic and social development to gain acknowledgment for achievements in attacking key S&T problems by gradually adopting them in production within 3 to 5 years and foster their appropriate economic and social benefits on schedule in economic construction and social development.

I feel that selecting and applying for projects to attack key S&T problems in the Eighth 5-Year Plan conforms to the laws of scientific development. It gives scientific research clear application goals from the start and will greatly reduce the time period for shifting scientific research achievements to production. Given this significance, research on principles for selecting, applying for, and establishing projects is extremely important. Those with a good grasp and profound understanding will see their work continually intensified and the benefits will be obvious.

B. Conscientiously do good appraisal and examination work. China's plan to attack key S&T problems is a large system. Given China's present administrative system, personnel quality, and work conditions, implementation of an administrative control method with goals divided by levels is rather appropriate. To attain the goals of fewer levels, clear job responsibilities, improved efficiency, and stronger management, we should implement a management model in which the three levels of integrated departments, presiding departments (or provinces and municipalities), and responsible units are the main lines. Practice during the last 3 years of the Seventh 5-Year Plan also has proven that this method is rather successful. Beginning with the project establishment stage during the Eighth 5-Year Plan, we should do our work strictly in accordance with this method. All projects included in plans should undergo comprehensive appraisal and examination by stages and levels. This also means that projects not formally submitted according to procedure by responsible units should not become established research projects. Presiding departments should not formally accept or consider project proposals when responsible units fail to submit feasibility forecasts. Integrated departments should not study the issue of including projects when presiding departments have not carried out comprehensive evaluation and strict checks and have not submitted project feasibility recommendations. The goals of projects to attack key problems can become clearer only by having administrative organs at all levels implement their own duties, handle matters according to procedures, and conscientiously do appraisal and examination work in each stage so that plans to attack key S&T problems during the Eighth 5-Year Plan achieve total and not partial optimization.

C. Unify rolling progress, integrate long and short-term arrangements. Because S&T progress and development are always faced with a continually changing external environment and internal conditions, and because people's understanding of objective things progresses in

steps and is limited, the prerequisites of medium and long-term plans continually change. To absorb experiences and lessons of work in the Sixth and Seventh 5-Year Plans and avoid the shortcomings of signing 5-year contracts which make changes difficult, the Eighth 5-Year Plan will adopt a method of rolling progress which means that a 5-year plan will be studied every 2 years according to a fixed procedure and that an annual implementation plan and budget will be formulated each year. Changes and content enrichment according to plan procedures during the forward rolling process will be permitted. This will make preparatory work more complete and better for projects included in plans. At the same time, decisions will be made as to which projects to proceed with first and which to move on slowly according to financial possibilities. This will mean that some of the many projects to attack key S&T problems will go first and others later, they will be dispersed according to sequence and have substantial competitive qualities, and they will be linked together in an orderly way with dynamic equilibrium. This will avoid the reappearance of a passive situation of excessively long scientific research battlelines, scattered investments, and a lack of guarantees for key projects.

D. In work methods, we should continue to foster the successful experiences and methods of the Seventh 5-Year Plan and pay attention to these questions:

1. Gain a foothold in 1991 and 1992, do overall planning for the Eighth 5-Year Plan.

2. Do good solid preparatory work for recommended projects, put everything in place.

3. Based on the principle of feasibility, choose those projects to proceed on first and those to proceed with later, with slanting and sequences.

4. Projects not begun in 1991 can be restudied in 1992. It is not necessary to force every project to be the "lead car" in the 5-year plan.

5. Do good typical guidance work for all primary links for key projects with mature conditions such as project establishment, debating, bid solicitation, contracting signing, and so on. In addition, perfect management methods, solidify work procedures, and make plans to attack key S&T problems more systematic, more standardized, and more scientific.

New Emphasis on High Technology

91FE0047 Beijing CHINA DAILY in English 1 Oct 90 p 3

[Article by Wang Gangyi]

[Text] Once, whenever the subject of science and technology came up, Chinese used to boast about the four great inventions—paper, movable type, gunpowder, and the compass—made by their ancestors more than 2,000 years ago.

While there is no doubt that these four inventions had a lasting impact on civilization, this indulgence in ancient glories did little more than lull the Chinese people into a sense of complacency.

In fact, when the country finally emerged from the decade-long chaos of the "cultural revolution" (1966-1976) and joined the international community again, it found itself out of the game in almost every scientific and technological arena in the world.

Then, in 1978, China began a comeback.

First came the rehabilitation of tens of thousands of intellectuals, scientists, and technicians who had been condemned to "labour farms" in poor and remote rural areas for reeducation. This was coupled with a call from the country's top leaders to respect knowledge and talents.

Then a number of development programmes were launched, involving thousands of scientists and millions of U.S. dollars in investment over the next decade.

Today, the picture has never been brighter.

Following several centuries of decline, a new urgency is animating the country. A national consensus has been reached among government departments, research institutes, and industries that if it is to catch up with the rest of the world, China's economic development must rely on high technology.

In March, 1986, four of China's scientists—Wang Dayan, Wang Daheng, Yang Jiaxi, and Chen Fangyun—proposed in a joint letter to Party and State leaders that China keep abreast of the latest scientific and technological developments in a number of selected fields.

The proposals won instant support and was transformed within a year into a detailed High Tech Research and Development Programme, also known as the "March '86 Programme."

Based on the country's research capabilities and economic strengths, and considering its strained financial resources, the programme has targeted the following seven areas in which breakthroughs seem possible: biology, space, information, lasers, automation, energy, and new materials.

The Commission on Science and Technology for National Defense is in charge of the space and laser research projects, while the State Science and Technology Commission (SSTC) is supervising the rest.

In the next 10 years, SSTC will funnel up to 10 billion yuan $2.1 billion) into high tech development. At the same time, the commission has initiated a companion programme, the "Torch Programme," to ensure that the scientific advances of the "March '86 Programme" will be put into commercial and industrial production.

The "Torch Programme" gives priority to products in the areas of new materials, computers, bio-engineering, energy-saving technology, micro-electronics, laser communications, information, and new energy sources, which have the potential to meet the urgent needs of China's industries.

The commission selected 283 projects from a list of approximately 1,500 candidates to focus on in 1988 and 1989. The projects were chosen because of their technical nature, suitability for commercial production, and potential for economic return, according to SSTC Vice-Chairman Li Xu'e.

In addition, more than 30 high tech development zones have been set up throughout the country. Last year, 2,065 high technology enterprises approved by the State in 15 major cities produced a total output value of 2.62 billion yuan ($556 million); their total export value was over $45 million.

Despite a late start, China enters the technology race with many advantages. Many of its basic science labs are first rate, and its space and biology research institutes are among the world's finest.

China's Long March series rockets have successfully lifted several dozen satellites into orbit and have edged into the highly competitive world space-launch market.

High-Tech Enterprise Development in Year 2000 Discussed

91FE0116 Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] 22 Oct 90 p 1

[Excerpts from article by Jin Zhouying [6855 0719 5391] and Qi Jianguo [7871 1696 0948] of the Quantitative Technology Institute, Chinese Academy of Social Sciences: "On the Status of High-Tech Industries in China's Future Industrial Structure"]

[Excerpts] High technology and high-tech industries cannot be seen as tasks only for scientific circles. The high-tech development process is a process of changing the industrial structure and raising grades. High-tech industries should become pillar industries of China's national economy in the year 2000. High-tech industries should adopt a three-dimensional development model of drawing by demand, promotion by technology, and technology importing.

In modern society, where S&T progress are playing an increasingly greater role in social and economic development, correctly understanding and evaluating the role of high-tech industries in economic development can have a profound effect on economic policymaking and thus can play a direct role in the economic development model and growth rates in a country and even determine its position in international competition. This question is of special significance for China.

[passage omitted]

II. High-Tech Industries Should Become Pillar Industries in China's National Economy in the Year 2000

China is now readjusting its industrial structure and formulating industrial development plans for the 1990's. Generally speaking, readjustment of the industrial structure and planning eventually should be implemented in strategic industries which foster development of the national economy and in key development industries for a particular period of time. This choice can be divided into two categories. One has the goal of correcting quantitative imbalances between supply and demand in the industrial structure. Its primary measure is accelerating development of "bottleneck industries". The second category has a primary goal of raising grades in the industrial structure and its measure is accelerating development of high-tech industries.

Overall, China's present economic and technological development levels are rather backward and we will be unable to become a developed nation during the Eighth 5-Year Plan by making high-tech industries the pillars of our national economy for comprehensively slanted development. We should soberly note, however, that we are both facing challenges and have many favorable conditions in the area of developing high-tech industries.

1. China has enormous S&T strengths and we are almost at or have attained advanced international levels in certain high-tech realms. China already has a huge industrial system with a full complement of categories. We have laid a multilevel high-tech industrial foundation. We have already established high-tech parks and zones with an initial scale and confirmed their obvious benefits. China has over 7,500 scientific research organs at the county level and above and a high-tech industry army of more than 3 million which includes 400,000 scientific research personnel. This staff is almost as large as the ones in the United States and Japan and larger than England's. We have already attained world vanguard status in many high-tech realms. We are first among the developing nations in S&T expenditures. Many countries have used this sort of S&T strength for large-scale development of high-tech industries and gained competitive capabilities in international markets. When we are formulating industrial development plans for the 1990's, we should make full use of this advantage.

2. China has traditional industries on an enormous scale but the structure is being degraded, technical levels are low, productivity is low, and they urgently need high-tech for transformation. This provides broad market conditions for developing high-tech industries. One of the main problems in China's economic development over the past several years has been a serious loss of balance in the industrial structure and rapid growth of backward processing industries to an extent which has greatly exceeded the capabilities of basic industry. We should no longer make meeting the needs of processing industries the goal of structural readjustment. Instead, we should begin by accelerating the application of high-tech for technical transformation in basic industry and the processing industry by on the one hand raising productivity and quality and increasing supplies in basic industry and on the other hand by raising technical levels and reducing consumption per unit output in the processing industry and reducing the degree of our reliance on traditional industry so as to use both the supply and demand aspects to take a step toward higher levels in our industrial structure. Because China has a shortage of foreign exchange, we cannot rely mainly on high-tech imports to transform China's enormous traditional industry system, so the only way out is to rely on developing high-tech industries ourselves if we are to achieve this goal. This also shows that transforming traditional industry will provide vast markets and primary battlefields for developing high-tech industries in China.

3. China will have a huge consumer market with a population of almost 1.3 billion by the year 2000. Although there are many different consumption levels in this market, consumer demand for high-tech industries cannot be compared with other nations. According to projections by the relevant research organs, yearly demand for high-tech products in consumer markets in China will reach 200 billion yuan in the year 2000. Objectively, this huge demand will form an enormous drawing force on high-tech industries. It also shows that there are full market conditions and capacity for developing high-tech industries.

4. By making additional readjustments in investment policies, preventing repeated imports and redundant low-level construction, and concentrating our national forces as appropriate, it will not be difficult to come up with investments to develop high-tech industries. On the surface, the main obstacle to China's development of high-tech industries is the capital shortage, but a little further analysis leads to the opposite conclusion. On the one hand, the capital shortage is a fact, but on the other hand, China wastes a frightening amount of investments. If we give high-tech industry development an important strategic status, provide policy support, and absorb the excessive amount of investments spent on large amounts of repeated imports and low-level redundant construction in the processing industry into developing high-tech industries, there would be no shortage of investments to develop high-tech industries and degradation of our industrial structure would not have reach such a serious point.

5. Competition on a world scale during the 21st Century will shift to the realm of high-tech industry. If we want to enable China to stand among the other nationalities of the world in the 21st Century, occupy a definite position of advantage in economic competition, and continually reduce our lag behind the developed nations, we must meet the challenge. There is no other road for us to take. Ten years of reform and opening up have established China's position in international competition and we cannot again ignore China's influence on international competition when planning our industrial structure. Beginning in the late 1970's, all the developed nations readjusted their industrial structure and accelerated development of high-tech industries. This trend will continue into the 1990's and will spread to a world scale during the 21st Century. In this type of situation, the attitudes and policies that each country adopts toward high-tech industries will have a profound effect on their international status in the 21st Century. During the 20-year period from 1963 to 1983, the trade volume of high-tech industries in the world grew at least 14-fold. Japan's GNP in the early 1960's was similar to China's but was four times China's in 1980 and five times China's in 1985. The "four small dragons" of Asia which had not yet received their names in the 1960's had an export volume more than three times that of China in the 1980's and there was a universal rise of grades in their industrial structures. One secret of their success was that they promoted economic development centered on high-tech industries. Beginning in the 1990's, we should use the "vitality" we supplemented in the 1980's to start facing the challenges of the world's new technological revolution and resolutely cultivate and support the development of high-tech industries that have prospects during readjustment of our industrial structure.

Our conclusion: In the 1990's (and not after the 2000), we should clearly make high-tech industries the strategic industries for development of our national economy, provide them with focused protection and support in our industrial policy, strive to make the value of output from high-tech industries that are normally mature account for 20 to 25 percent of our gross value of industrial output and the value of output from high-tech products that are at the vanguard account for 10 to 15 percent of our gross value of industrial output, make high-tech industry groups an important pillar industry for development of our national economy, technical progress, and exports to earn foreign exchange, and attain levels of the developed nations of the 1980's.

III. Development Models and Countermeasures for China's High-Tech Industries

The inherent relationship between technological progress and optimization and raising grades in our industrial structure is most clearly revealed in the development of high-tech industries. As a result, there is an extremely close relationship between the development model for high-tech industries and the model for technological progress. We feel that, from the perspective of macro technology policy, technological progress in China should adopt high-tech as its tap, use high-tech industries to transform traditional industry, and enable industrial technology to achieve a leap-type progress model in order to promote optimization and rising grades in the industrial structure. From the perspective of motive mechanisms, we should adopt a three-dimensional compound model of guidance by demand, propulsion by scientific research, and technology imports. In correspondence to this, high-tech industries should adopt a three-dimensional development model of pulling by demand, carrying along by technology, and technology imports. China adopted a parallel model of guidance by demand, technology imports, and propulsion by scientific research in the late 1970's. The main problem was that the three were never organically fused into one body. Technology imports repeatedly imported production capacity on a large scale without integrating organically with scientific research and development in China or carrying out assimilation and innovation. The enormous enterprise technical transformation market and consumer market have not formed a drawing force for China's own high-tech industries. Instead, they have drawn large amounts of repeated imports of high-level consumer products and production lines, provided a market for foreign high-tech industries, and wasted a large amount of valuable foreign exchange. Development of high-tech industries in the 1990's must deeply absorb this lesson and adopt powerful countermeasures to reinforce integration of technology and the economy. For this purpose, we propose:

1. Firmly establish adherence to the four basic principles as the basis for administering our country, use reform and opening up as the route to strengthening our country, use S&T progress as the source of consciousness for bringing prosperity to our country, make them the overall principle for economic construction, establish an economic development strategy of using S&T to bring prosperity to our country, and give development of high-tech industries an important status in planning for economic construction and the industrial structure.

2. The State Council (or National People's Congress) should establish a 1990's S&T national prosperity discussion conference to break down the separation of the old system based on the overall economic development principle of using S&T to make our country prosperous, carry out unified coordination and implement integrated management for technology policy and industrial policy, and organically integrate technological progress with economic development and readjustments in the industrial structure with development of high-tech industries.

3. The government should intervene as appropriate in the development of high-tech industries and adopt slanted policies for a suitable amount of protection and support, including preferential financial and banking policies and appropriate trade protection policies.

4. Use high-tech innovative enterprises as the breakthrough point in enterprise reform, implement a new management system and benefit allocation system. For the management system, all administrative authority should be given to enterprises with the state retaining only legal auditing rights, legal taxation rights, rights to obtain profit distributions according to the proportion of capital invested, and so on over enterprises to carry out indirect administration of enterprises using industrial and technology policy and economic measures instead of management by administrative measures. For benefit allocation mechanisms, the status of enterprise management in profit allocation should be acknowledged and enterprise after-tax profits should allocated to the structure of enterprise investments in fixed assets, added value rates, and other factors to encourage self-restraint and accumulation in enterprises.

5. Continue to develop and perfect all types of high-tech experiment development zones, attract skilled personnel from a broad area, ensure that personnel can circulate freely within and outside of the development zones, create a micro-environment adapted to innovation inside the experimental development zones, and make them true incubation zones for high-tech industries.

6. The state should establish comprehensive R&D information networks for high-tech industries to serve high-tech R&D enterprises without compensation or with low-cost compensation. The range of services should include R&D information inquiries, product supply and demand information for domestic and foreign markets, legal advice, opening channels for foreign exports, and so on to create the conditions for high-tech industry development.

7. The state can participate directly in high-tech industry development that is of major significance for development of the national economy and raising grades in the industrial structure by organizing national scientific research organs, universities, and enterprises for integrated horizontal attacks on key problems and actively extending and dispersing new technology to accelerate development of high-tech industries.

8. Establish mechanisms for raising capital for risky investments, including the establishment of risky investment banks, permit high-tech enterprises to issue stocks and bonds and allow them to be traded in the market, exempt income from stocks of vanguard technology development enterprises from income taxes, and so on.

9. Start with education, train high-tech R&D administrative and management personnel, make a major effort to popularize knowledge on high-tech, and strengthen our national understanding of high-tech and willingness to develop high-tech. This is a social support soft environment that is required for development of high-tech industries and it should receive a high degree of attention.

Promoting the Growth of High-Tech Industries

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[Article by Xia Guopan [1115 0948 3382] of the No 608 Research Institute in the Ministry of Aviation and Aerospace Industry: "Reinforce New Strengths for Technological Innovation, Promote Development of High-Tech Industries"]

[Text]

[Abstract]

This article discusses an economic development model which has technological innovation as an inherent mechanism, analyzes the role of technological innovation in promoting the formation and development of high-tech industries, focuses on the four links of reinforcing market development capabilities, industrial design capabilities, product trial manufacture capabilities, and batch production capabilities, and describes the theoretical concept of using reinforcement of the strength of technological innovation to accelerate the conversion of S&T achievements into commodities and industrialization of high technology.

The concept of technological innovation has a broad and rich connotation. According to definition by the U.S.-born Austrian economist Schumpeter, it refers to inventing or importing a new product, extending a new product's functions, obtaining new sources of raw materials or opening new market channels, adopting a new production arrangement or applying a new management method, and so on. It includes the entire process of economic and technological integration and it involves multilevel scientific and technical activities with many interlinking and intersecting links. A relatively key common point of theoretical concepts concerning technological innovation in China and foreign countries is that a product innovation should corner a market or obtain a definite portion of a market to achieve market benefits and economic benefits. This is a point of difference which distinguishes technological innovations from scientific creations, inventions, and discoveries. Of

course, this does not deny that technological innovations must be nourished and enlightened by scientific creations, inventions, and discoveries. It is apparent that technological innovations are a product of a market economy and that the ever-increasing intensity of market competition inevitably drives development of innovation. This shows that technological innovation is a comprehensive work process that includes the entire process of information, development or importing, intermediate testing or assimilation, production, and marketing, that it is an economic development model which uses markets as a guide and relies on new product development and marketing as a tap to accelerate the conversion of S&T achievements into commodities, and that it is a concept of economic and material production.

Another obvious point concerning modern technological innovation is that it is interrelated with development of high-tech industries. Because of the high degree of merging of high-tech industry technology with the economy, the entire process of technological innovation must be included within a single unified system to enable the formation and development of high-tech industries. Because it is in competition with international high-tech industries, there must be a "propulsive force" which relies on technological innovation, product development, and multiplication into product systems, which inevitably lead to raising and upgrading of an industry's structure. Propelled by technological innovation, high-tech industries have now become a pillar of economic strength in all nations of the world today. According to the related information, high-tech products accounted for 25 percent of the total volume of world trade in 1987. For this reason, many nations are extremely concerned with research and practice in technological innovation. The OECD and EEC have both formulated technological innovation policies and powerful technological innovation mechanisms have become a direct source of economic growth in the West. The Reagan government's "State of the Nation" report in early 1987 offered competing plans for a comprehensive strategy and substrategies to reinforce technological innovation. The rapid economic growth in post-war Japan was due to a substantial extent to a "national innovation system". Beginning in 1982, Sweden's guaranteed investment strength in technological innovation quickly eliminated the situation of economic stagnation in the 1970's and brought rapid restoration. Thus, flourishing vitality in technological innovation is a motive force in sustained social development. This has already been confirmed by years of practice in international economic development.

Since the 3d Plenum of the 11th CPC Central Committee and following gradual intensification of reform in the economic and S&T systems, national defense scientific research, especially research and design units in the Ministry of Aviation and Aerospace Industry, have changed the past tendency toward "major efforts to announce completion when an achievement is in hand" and adopted the tactic of "stabilizing scientific research, encouraging innovation". They are concentrating on converting their own comprehensive advantages in technologies, equipment, and organizational systems engineering into market advantages, shifting aviation technology into adjacent high-tech realms, and striving to create new products. Among them, using centrifugal turbine expansion cooling technology to develop large and medium- sized turbine expansion cooling machinery used to recover natural gas in oil fields, using augmented combustion chamber technologies to develop an inert gas generator used to extinguish coal mine fires, using aviation testing technologies to develop the JK-8241 bearing gear breakdown monitoring system instruments used to diagnosis rotation breakdowns in machinery, and so on, were all successful examples of technological innovations. Today, facing the challenges of the new technological revolution of the 21st Century, our aviation S&T industry should make "high technology, large markets" its strategic goal and make technological innovation a strategic measure to reinforce our international competitiveness and reinforce research on combined military and civilian use of S&T achievements and land-based use of aviation equipment and commodities by making multiple uses of a single thing to gradually form a new generation technical structure which integrates military and civilian uses and is dominated by high technology, high added value, and high foreign exchange earnings to further develop technological innovations and accelerate the pace of "shifting from military to civilian production, shifting from domestic to international markets". To adapt to the requirements of these new situations and new tasks, we should reinforce cyclical operational mechanisms which integrate markets, design, trial manufacture, production, and markets and continually strengthen technological innovation.

I. Reinforce Market Development Capabilities

Weiss, a former advisor at the World Bank, stated in his book "Technology Choices and Management in the Developing Nations" that the appearance of many technological innovations was "market induced", meaning that enterprises grasp market demand and are then induced to make innovations to satisfy the demand. Markets are both final points of technological innovations and starting points of technological innovations. Many "S&T-type" market development personnel with administrative skills who focus on managing sales of high-tech products must be trained to effectively increase our capacity for market development.

1. Increase the capacity for selling innovative products, reduce marketing schedules. Marketing is a weak link in China's business enterprises. The relevant statistics show that the one- time circulation cycle for capital in China's enterprises is 104 days, but it is less than 10 days in the developed countries. The achievements and products of China's scientific research and design units often fall into dire straits because they are unmarketable. This requires borrowing the tactic of time creation advantage from the marketing master Taylor by entering technology markets, participating in commodity exhibitions

and sales, making orders after seeing samples, establishing marketing networks, and adopting export agent systems to connect with users and market products to achieve the goal of "goods that not do stop at their genesis".

2. Improve capabilities for providing post-sales services and analyzing supply and demand. Use post-sales services to create brands and establish images, observe the value after an S&T achievement is converted into a product and the competitiveness of its products in the market, determine the newest requirements and latent demand of consumers, and suggest ideas in advance for improving and modifying products, upgrading and replacement, and developing new products.

3. Improve the capacity for forecasting S&T development trends and formulating ideas for response measures in advance. Use analysis and understanding of marketing activities, scientific projections of new technologies that may appear in their own disciplines and specializations and in related fields, and their effects on markets to continually suggest contents and projects for technological innovations based on multiple perspectives and debate from all positions for the opportunities and challenges that face our scientific research units and induce leading development of new products based on scientific foresight.

II. Strengthen Industrial Design Capabilities

Industrial design is an S&T activity that transforms S&T achievements into production technology, and it is the basis for making technical preparations and organizing production and trial manufacture. It is "innately" the basis for determining the inherent quality and reliability of a product. This is especially true for the enormous wealth implied from adapting to the present emphasis on name brand designs. A research project in the United States shows that the profits from each every dollar spent on industrial design can be as much as about $1,500. Many countries are now strengthening industrial design as a national policy for promoting development. The government of England, for example, has made product design the lifeblood of industry. In 1982, British Prime Minister Mrs. Thatcher personally chaired an industrial design discussion meeting at the prime minister's residence and in 1988 England invested over $20 million in design. After World War II, the United States economy ruled the world and one reason for this was that the founder of German industrial design ideology, (Geluobisi) and his colleagues came to the United States and transmitted modern design concepts which took full advantage of the United States' technology and resources. For this reason, scientific research and design units must overcome their tendency to "stress research and neglect design" and focus on reinforcing industrial design as a major matter which concerns the rise and fall of our nationality and promotion of innovation. Reinforcement of industrial design capabilities should focus on the following areas:

1. Optimize the knowledge structure of design personnel, improve the capacity for superior designs. This mainly involves continued engineering education to enable our large numbers of design personnel to grasp systems engineering theory, control theory, optimum choice methods, man-machine engineering, mathematics and statistics, value engineering, computer applications, and other disciplinary knowledge and enable them to foster their creative ideas throughout the five stages of feasibility analysis, preliminary design, technical design, work chart design, and final design for the entire design process so that their own designs meet people's requirements for product materials and functions and satisfy the people's aesthetic and interest requirements to unify S&T and culture.

2. Do good secondary technical development, improve the capacity for S&T "conversion". We must continually induce creative design ideas in industrial design, promote "conversion" of S&T achievements into production technology, "conversion" of military technology into civilian technology, "conversion" of aviation technology into land-based technology, and "conversion" of traditional technology into high technology, increase the technical content of innovative products, search for high benefits and high added value in the products themselves, basically achieve one product renewal every 3 years, and maintain powerful competitive abilities.

3. Reinforce research on reverse engineering, improve the capacity for assimilating imported technology. The ratio between expenditures on technology imports and funds for assimilation is 1:10 in Japan and 20:5 in China. To change the tendency to "stress imports while neglecting assimilation", we should strengthen reverse engineering and digest, absorb, improve, and develop imported technology, take advantage of our vast population, and raise design starting points. An example is importing and digesting French engine technologies as a basis for reverse design and absorbing new engine technologies from foreign countries for development and innovation to design and develop our own new type of engine, which moved China's medium-sized and small engine technology quickly up to advanced levels of the 1980's and increased the economic benefits from the imported technology.

4. Renew design measures, shorten design schedules. This mainly involves doing research on microcomputer technology applications and gradually adopting computer-aided design data processing and graphics databases to improve design efficiency and accelerate design progress.

III. Reinforce Product Trial Manufacture Capabilities

Product trial manufacture is the embodiment of design technology. The core of technological innovation should be product trial manufacture and development. For a long time, trial manufacturing capabilities in our aviation science research units have been weak and there are problems of outdated equipment, exceeded service lives,

backward techniques, and so on. When research institutes transfer new technical products to enterprises, the fact that they have not undergone trial manufacture and testing often means they are not sufficiently mature and may even be a step backward. Thus, we must adhere to the spirit of the need to "give S&T organs the capacity for self- development and the capacity for automatic economic service" that was emphasized in the CPC Central Committee decision concerning reform of the S&T system and reinforce product trial manufacture capabilities.

1. Develop soft trial manufacture lines, improve equipment processing capabilities. Given the characteristics of a large variety of products, rapid model replacement, and high precision in scientific research units, we should gradually develop electromechanically integrated soft trial manufacture lines to complete processing tasks for different workpieces and different types of trial manufacturing in order to reinforce trial manufacture measures.

2. Supplement equipment in short supply, increase equipment matchup capabilities. All nations of western Europe are now increasing investments in equipment to make good preparations for 21st Century rivalries. In the area of equipment transformation, France, which had delayed the opportunity, is now taking great strides to catch up. They increased their industrial robots alone by 30 percent in 1988. Based on China's national conditions and the characteristics of aerospace high technology and the principle of high efficiency and conservation, we must increase precision, special, and shortage equipment, raise matching levels, focus on supplementing high precision numerical control machine tools and non-overmeasure precision blank technology and equipment, and increase the proportion of applications of laser, plasma, electron beam, electron corrosion, electrochemical, and other non-traditional equipment.

3. Optimize technical structures of trial manufacture lines, improve technical qualities. Our focus should be to improve technical flow processes, raise technical levels, improve technical equipment, broadly apply new technologies, new techniques, new materials, and new procedures, extend advanced surface protection and decoration technologies, improve work structures and perfecting inspection measures, reinforce measurement standards, transmission systems, and comprehensive quality control management systems, and use exquisite techniques and technologies to guarantee successful product trial manufacture.

4. Train senior technicians, increase the capacity to attack key problems. All the developed nations are now paying extremely close attention to training senior technicians. In Japan, senior technicians are known as "technical sages" and skilled workers in South Korea are called "foundations of a pyramid". In recent years, the proportion of all employees who are senior technicians was 38 percent in the United States, 32 percent in Japan, and 29 percent in the Soviet Union. For technicians in China's scientific research units, because the older ones have retired and the young ones are in school, there are not many senior technicians left, which has seriously affected trial manufacture of innovative products and operation and maintenance of advanced equipment. For this reason, we must establish the new concept that "senior technicians are technical treasures", include senior technician training in state economic development and personnel training tracks, use professional training, technician appointments, on-the-job training, and various other routes to train an "intelligent" senior technician staff, increase their capacity for attacking key problems in trial manufacture, and ensure the conversion of S&T achievements into commodities.

IV. Improve Batch Production Capabilities

Producing economic quantities is a fundamental condition for increasing the benefits of innovation. Before any innovative product attains economic quantities, because fixed costs are about the same as product costs, they often have no economic benefits, so it is even harder to form innovative strengths. For this reason, our scientific research units should not stop at the level of prototypes, single units, and small quantities. All high-tech products which have fixed models in trial manufacture and have passed market tests certainly should be placed into commercial production on the basis of increasing output rates, intensive expansion of production scales, and exploring a new route to industrialization.

1. Established specialized production lines, increase automated production capabilities. With a prerequisite of conforming to China's industrial strategies, avoiding regional tendencies toward assimilation, and protecting the military industry, we should develop the specialized equipment required for batch production, carry out technical transformation on the basis of scientific research unit trial manufacture plants, establish specialized production lines, and organize batch production of fist products. After 2 or 3 years, we should again expand and disperse them to enterprises and try reorganize batch production of replacement products to explore the new path of studying S&T achievements, developing new products, and developing radiating enterprises.

2. Establish production management enterprises, form new forces of production. This refers to scientific research organs themselves setting up enterprises under ownership by the whole people or collective ownership and bringing in the full range of operational mechanisms for civilian-run S&T activities centered on markets and implementing high efficiency, simplified, and rapid scientific management to form an integrated development, production, marketing, and service body. The Dongfang Electrical Appliance Co., Ltd. and Quartz Clock Plant set up by our scientific research institute uses laboratories as technical reserves to work on product varieties, quality, and levels to gradually form a large batch production capacity, and begin using continually growing economic benefits to support scientific research and innovation.

3. Absorb enterprise inputs, develop group production capabilities. Enterprise groups of scientific research organs which use famous and superior products as a bond, use S&T as an vanguard in attracting enterprises and development, and are centered on scientific research institutions integrate, optimize, and organize personnel, technology, equipment, and information advantages, start with specialization of production and an outward-oriented economy, and use a group promotion arrangement to organize large batch production.

4. Adapt to market mechanisms, improve the quality of production management. The focus at present should be on promoting the Hengshui Shuguang Plant's "full-staff efficiency management method", the No 2 Automobile Plant's "single-flow production arrangement", Qiuyang's "labor increment dynamic management", and other "software products" to provide advanced experience, reinforce the concept of time benefit value and capital time value, and stimulate the productive initiative of employees.

In summary, by reinforcing the strengths of technological innovation in the "four links" described above, scientific research units are focusing on promoting the primary factors in innovation, focusing on intermediate links in industrializing high technology, and with a prerequisite of obtaining support from society and dealing with innovation inputs, they can effectively accelerate the pace of converting S&T achievements into commodities and industrializing high technology. Today, as we are moving from one century to another, there is a new global technological revolution that is characterized by the development of high technology and the establishment of the high science and technology industry. We must strengthen our consciousness of technological innovation, establish a development model with technological innovation as an inherent mechanism, promote the shift of our economic structure toward high technology levels, and welcome the arrival of the new century.

Problems Encountered in Developing Civilian Products by Military Research Institutes

90FE0290D Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 3, May 90 pp 53-54, 25

[Article by Zeng Jianlong [2582 1696 7893] of the Ministry of Aviation and Aerospace Industry: "Problems and Countermeasures in Development of Civilian Products by Military Industry Scientific Research Institutes at the Present Time"]

[Text] **Abstract**

This article analyzes the main problems in development of civilian products by military industry research institutes, which are rising costs and low prices, abrupt reductions in development contracts, declining income from civilian products, insufficient funds for subsequent development, and growing development risks. This article suggests using unified ideology and coordinated action to readjust and optimize product mixes and development directions, reinforce management and reduce costs, improve product quality and strengthen competitive capabilities, and create the conditions for the state to use special S&T development funds and other measures to overcome problems, foster advantages, and serve construction of the national economy.

(I)

China is now in a period of economic readjustment. We are implementing the "two urgents" policy concerning finances and money to effectively control inflation. In another area, however, this presents many real problems for civilian product development work in military industry research institutes which have just begun to take steps to shift from military to civilian production. These are manifested mainly in the following areas.

1. Squeezing Upward and Downward, Difficult Straits

Squeezing upward refers to rising costs that are squeezing upward. Social inflation in recent years has resulted in rising prices for raw materials, fuel, fixed assets and equipment, manpower, capital, and other factors of production and higher total costs calculated in monetary terms. This is especially true since implementation of the dual-track price system in recent years which has played a special role in price increases for factors of production in the electromechanical industry. Moreover, civilian product development in research institutes is done against a background of substantial reductions in state military product tasks and products or projects are developed according to market demand, which makes their inclusion in state directive plans difficult, prevents guarantees for raw materials supply channels, and prevents price guarantees. The result is development costs that erode profits. For Chinese-made small-scale automated bread production lines, for example, the total cost of a production line in 1986 was 230,000 to 240,000 yuan. According to 1989 price appraisals and decisions, these costs have risen to 290,000 to 300,000 yuan.

Downward pressure refers to prices that are too low, which creates pressures on profits. The technology in high-technology products developed by military industry research institutes has substantial added value and includes much more simple labor, but product prices are usually lower than their value. Again using a state import substitution product, small-scale bread production lines, as an example, although the manufacturing cost is higher than similar products in foreign countries, the price is just one-fourth to one-third the price of foreign-made products. The reasons, besides several subjective factors in scientific research institutes themselves, are due to the background of their civilian product development. Because they lack regional or industry protections like other civilian industries, when they decide on development contracts with other industries or regions, they

often have to bear high technology and first-time development risks to make transactions at low prices. Another reason is the irrational price system. There are no price encouragements for high risk and high technology added value development labor. It is precisely because development costs are staying high while prices remain low that development profits are extremely small and research institutes find themselves in desperate straits.

2. Abrupt Decreases in Development Contracts, Declining Income From Civilian Products

Because of tight money and shortages of enterprise capital, especially insufficient circulating capital, enterprises now can only sustain simple reproduction and cannot carry out large-scale technical transformation projects. Markets are weak and consumer buying enthusiasm has declined. These factors have caused a substantial decline in product sales and development contracts compared to previous years. The quality question, hidden in the past, has revealed itself and users are placing ever-higher demands on performance, appearance, after-sale services, and other areas for products or items.

3. Inadequate Capital for Subsequent Development, Growing Development Risks

Because of their tiny incomes and insufficient capital, research institutes retain a very small proportion of capital for subsequent development. Their income is basically used for expenses and bonuses, which means that research institutes have no funds for technology survey research, technology tracking, technical improvements, and other areas. Their ability does not equal their ambition, so they sometimes resort to squeezing funds from military industry projects. This undoubtedly increases project development risks and increases the indeterminancy of product development. This causes many problems for guaranteeing the advanced qualities and reliability of projects, understanding the current situation in project operation, and improving product quality.

(II)

Although economic readjustments have created real problems for civilian product development in research institutes, from another perspective they have also brought opportunities for development. At present, besides the need for state policies to provide suitable protection for the shift from military to civilian production, research institutes should also have a complete set of immediate measures to overcome problems. We feel that the overall tactic is "squeezing inward and expanding outward." The actual measures involve focusing on work in the following areas.

1. Unify Ideology, Coordinate Activities

Internal ideology in research institutes has consistently been the basis for tiding over difficulties. We now should unify understanding in several areas. One is understanding the current situation in civilian product development. Although the state is in a period of economic readjustment and changing industrial structures, this is also an excellent opportunity for technical development and fixed asset renewal in enterprises. Research institutes can achieve very good development with appropriate tactics. The second is understanding the long-term nature of civilian product development. We cannot turn back as soon as we encounter temporary economic difficulties and return to producing only military products. Integration of military and civilian production cannot be done all at once. Instead, it concerns the major issue of shifting S&T toward the realm of production. The third is understanding integration of military and civilian production. Integration of military and civilian production is a historical inevitability and benefits both the military and civilian areas.

2. Readjust and Optimize Product Mixes and Development Directions

After almost 10 years of trying to shift from military to civilian production, research institutes have accumulated rich experience in civilian product development and formed their own special product development directions and product mixes. Now, they should use markets as a guide and take aim at industrial sectors that the state urgently needs to develop by focusing development to form advantages. Concretely speaking, they should develop projects first in the agricultural, energy resource, communications, and other sectors according to state industrial development sequences and adhere to the principle of "relaxation amidst urgency" to adapt to economic readjustments and strive for existence and growth in readjustment. In summary, full consideration must be given to the advantages of scientific research institutes, market effectiveness, and economic rationality in development directions to achieve a better balancing point. In product mixes, we should still emphasize "package" product tactics to give particular emphasis to many product tactics to adapt to a market with many changes.

3. Reinforce Management, Reduce Costs

Reducing costs and increasing profits is another way to overcome problems. We must reinforce cost management in design, standard inspection, trial manufacture, installation, debugging, transfer, utilization, and all other links, both for new project development or re-application of old technologies, and in particular we should control non-productive outlays. Concretely speaking, we should reinforce management in the following areas: 1) Project selection management. Project selection should give full consideration to economic, technical, and other factors and try to apply advanced decisionmaking methods including computer network technologies, regressive linear analysis techniques, and so on to make accurate estimates of market prospects and avoid mistakes in project selection caused by short-term behavior. 2) Design management. We should

improve the quality of designs, standardize design standards, and rationally select design programs. Cost management cannot categorically emphasize high risk coefficients and senselessly expand costs, nor can it ignore the reliability of projects and items because of an excessive emphasis on costs. 3) Trial manufacture and debugging management. Special attention should be given to processing technology lines, raw materials inputs, fixed asset utilization, and manpower and capital calculations during the project trial manufacture process to prevent costs from growing. 4) Marketing management. When development of a project is complete, we should perfect the technology and reinforce improvement during practice and we should use all possible routes to expand its effects and use extension to increase social benefits and the economic benefits for scientific research institutes. We should select appropriate extension measures, ranges, and regions during the marketing process and reduce marketing costs by increasing marketing benefits.

4. Improve Product Quality, Increase Competitiveness

In the present market situation, product quality is especially important and it has become an important matter of life and death concern for enterprises. For many years, perfecting product quality systems has become a basic point in establishing the military industry in the forest of civilian product development. In the future, we should make greater use of this advantage, focus on quality controls in all links from survey research and design to project transfer and utilization, apply modernized quality management systems, measures, and methods, further raise product quality management levels, use superior quality products to increase competitiveness, gain the trust of users, and win markets.

5. Create Conditions, Try for a Special State S&T Development Fund

To promote reforms in the S&T system and service to economic construction by S&T, the State Science and Technology Commission and other relevant departments have established the Torch Plan, Spark Plan, Key S&T Achievement Extension Plan, and various other development funds as well as three State Scientific Experiment Funds to support development, utilization, and extension of high technology. With their advantages in high technology development, high quality guarantees, and other areas, military industry scientific research institutes merely have to work hard to make accomplishments in these realms.

How Military Products Research Institutes Effect Strategic Change

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[Article by Liu Kai [0491 0418] of the Ministry of Aerospace Industry First Academy: "How Military Products Research Institutes Are Achieving a Strategic Shift"]

[Text]

[Abstract]

This article introduces some experiences and theoretical reflections from the No 1 Design Department of the Ministry of Aerospace Industry First Academy during the process of shifting from a scientific research unit that focused on military products to one that integrated military and civilian production, in particular the need to establish new concepts and new ideas for developing civilian products and the need to establish new systems and new methods to help promote the strategic shift toward development of military and civilian integration in military products scientific research units.

In the more than 30 years since the nation was established, China has relied on its own forces to develop and produce missiles, the atomic bomb, hydrogen bomb, artificial satellites, and carrier rockets, and we have grasped satellite recovery technologies. These achievements show that China's national defense industry has entered advanced international ranks. These achievements were made because the state invested large amounts of manpower, materials, and finances in military industry departments which enabled them to gradually form a scientific research system with highly concentrated technology, equipment, and intelligence. Under direction by the CPC Central Committee's principles of reform, opening up, and invigoration, China's military industry enterprises are now facing a strategic transformation which requires them to shift from the three old types of the past of the "purely military industry type, purely scientific research type, and closed type" to three new types of management models, "integration of the military and civilian industry type, scientific research and production management opening up type, and open type". As reform intensifies and develops, how can military industry enterprises take a major step on the road toward integrating military and civilian production? How can scientific research units that focus on development of military products, with a prerequisite of ensuring the completion of military product tasks, develop civilian products and achieve a strategic shift to integration of military and civilian production? All units are now exploring this question. The No 1 Overall Design Department in the Ministry of Aerospace Industry First Academy, a typical scientific research unit focused on military products, has made definite achievements in achieving a strategic shift to military and civilian integration and taken a gratifying step.

The No 1 Overall Design Department was the overall design department for missiles and carrier rockets and has consistently taken on overall design tasks for all types of China's missiles and carrier rockets. For a long time, the No 1 Department has involved many of its S&T personnel in development and design. It has received 215 major S&T achievement awards. Its military product projects have always been the primary scientific research projects in the No 1 Department, and

its S&T personnel working on military products account for 70 to 80 percent of its total personnel.

How can a unit so extremely full of military products like the No 1 Department take the path of military and civilian integration, and will it be able to shift personnel to develop civilian products? The technical personnel in the No 1 Department have been developing military products for decades. Can it make this transition? As progress in reform of the economic system proceeds, everyone understands that "without military products there is no stability and without civilian products there is no wealth". Only through resolute military and civilian integration, fostering technological advantages, developing superior quality products, providing top quality services, and focusing on social benefits will it attain self-development.

For several years, with a prerequisite of completing military product tasks, the No 1 Department has transferred key forces and assembled personnel in a major effort to develop civilian products, start projects, produce products, create value, and increase benefits. In more than 4 years from 1984 to October 1988, they achieved a total of 73.41 million yuan in value of output of civilian products and total income of 20.32 million yuan from civilian products, and paid a total of 4.84 million yuan in profits and taxes to higher authorities. They exceeded their economic indices assigned by the First Academy every year and have consistently been in the front ranks of the entire academy. Since 1984, they have raised their own capital to build 199 new houses with structures that cover an area of 15,600 square meters which have basically solved the housing problems of their S&T personnel.

The civilian product items developed by the No 1 Department have been acknowledged by the state and society. One product received a superior new product design award. Two products were included in fixed point production product varieties by the State Central Pharmaceutical Management Bureau. Three products received superior new product "Golden Dragon Awards" issued by the State Economic Commission. Four products were included among power station matching products for the Seventh 5-Year Plan by the State Machinery Commission and Ministry of Water Resources and Electric Power. Thirteen products have passed ministry, academy, and city-level technology appraisals. In the past several years, we have signed over 750 technical consulting contracts, provided top-quality technical consulting and technical services for enterprises in all areas, and effectively supported equipment transformation, equipment updating, and product updating and replacement in local enterprises and township and town enterprises.

Practice had given everyone a profound understanding that scientific research units in military industry departments must rely on reform for their existence and development and have no future without reform. Only reform can put military industry enterprises on the path of benign cycles and move them out of their own little world of military industry scientific research and toward the main battle of the national economy. How can the shift to integration of military and civilian production be achieved?

I. Eliminate Five Types of Ideas, Comprehensively Renew Concepts

In making their strategic shift, military industry enterprises first of all should change concepts and further liberate ideology before they can further liberate the forces of production. In concrete terms, they should eliminate five types of ideas:

1. Eliminate the idea that developing "military products" and taking familiar paths is their duty and insurance while developing "civilian products" and walking with difficulty is a "sideline" and involves risks.

They should change from the ideology of relying on unified state plans, sitting and waiting for higher authorities to unify tasks, and simply relying on military products for development to using markets as a guide to carry out administrative decision-making, achieve integration of military and civilian production, and serve the four modernizations drive.

2. Eliminate the ideology of depending on the state for unified allocations of funds and materials and "eating military grain".

They must shift from the supply system to utilizing financial market regulation and raising their own development capital, independent management, take responsibility for their own profits and losses, and utilize materials markets to regulate surpluses and shortages of materials and equipment.

3. Eliminate the ideology of products that rely on unified state purchasing and unified acceptance.

They should develop their own products, find their own sales avenues, establish corresponding management mechanisms, and move from a closed-type purely scientific research and production type system to an open scientific research, production, and management system.

4. Eliminate the ideology of being self-contained, large and complete, and never asking for help.

They must foster advantages and avoid disadvantages, foster their own advantages, carry out various forms of horizontal economic and technical integration, go outside, break down departmental boundaries, and form group forces.

5. Eliminate the past custom of independent management and independent monopoly of military product production.

Shift to importing market competition mechanisms, dare to compete and take risks, seek development in competition and risks.

II. Clarify Guiding Ideologies, Determine Work Principles

During the process of achieving the strategic shift, we must eliminate the old concepts and old ideas that were formed over several decades, and we must decide on a complete set of civilian product work principles which will become the starting point for future civilian product work and the foundation for guiding future work. The No 1 Department has clearly pointed out:

Follow one principle: this is the strategic principle of "integrating military and civilian production";

Aim in two directions: Orient toward technological renewal and technical transformation of the national economy, orient toward township and town enterprises and new product development;

Three goals of struggle: Produce skilled people, produce achievements, produce results;

Four management principles:

Observe agreements: Comply with contracts, reputations first;

High quality: Quality first, concern for results;

Small profits: Mutual benefits, rational charges, do not put profits first;

Five integrations:

Military and civilian integration: Make military products the main factor and civilian products the source, take on heavy burdens from the two outfitting departments;

Technology and trade integration: Convert technological achievements into commodities, integrate technology and trade;

Integrate with inside and outside parties: integrate with those inside and outside the units, inside and outside the Ministry of Aerospace Industry, and in China and foreign countries, foster the advantages and skills of each;

Integrate above and below: Motivate and foster the two types of initiative, integrate leaders with the masses, integrate organs and administrative offices;

Integrate the short and long terms: integrate development of products that are "short, easy, and quick" with development of those that have long-term economic benefits to form stepped products.

III. Establish Technical Companies, Make Suitable Separations Between Military and Civilian Products

Competition for personnel between military and civilian products, failure to implement civilian products, difficulty in implementing contracts, disorganized directions and dispatching, and other phenomena often occur in scientific research units which focus on military products. They must work on both the military industry and civilian products, so how to organize and coordinate military and civilian scientific research tasks and staffs is an important problem that must be resolved. The No 1 Department understands that doing good work on military and civilian integration certainly requires the establishment of technical development companies, appropriate separation of military and civilian staffs, and unified direction and unified guidance under the principle of "both ends fixed, middle intersecting, unified arrangements".

Establishment of technical development companies in scientific research units is a new try in reform of the scientific research system. Internally, it takes on the activities of civilian product professional organs and externally it represents the unit in carrying out civilian product development, technical consulting, product management, technology transfers and other activities, so it has the properties of a legal representative. Its basic tasks are to use administrative methods and circulation channels to extend and apply the development achievements of the scientific research unit. A development company and S&T offices which dispatch military products form a dual-system military and civilian product scientific research guidance and dispatching system.

The company serves as a civilian product direction and dispatching organ for scientific research units. After it takes on various types of projects for outside parties, it can consider appropriate allocations to each research office based on the specializations of each office, amount of work they are doing, how many civilian products they are now working on, and other conditions, and it can quickly organize the relevant research personnel to attack key problems in development. In this way, after civilian product tasks are assigned, there are people to receive them, organize them, and coordinate them, which can ensure contract implementation. In the area of personnel implementation, each office establishes keen-witted and capable fixed civilian product groups, and these personnel can organize development of civilian products according to the special capabilities in their own office and carry out independent development. This ensures that when they are busy working on military products, each office will also maintain a small group of key forces to work on civilian products to allow long flows without cutting lines. When they are not busy with military product tasks, they can use this small team as a basis for rapidly undertaking civilian product work in the entire office. This eliminates the phenomena of people not working on civilian products when they are busy with military products and having nothing to do when work on military products is slack.

IV. Foster Technological Advantages, Develop Superior Quality Products

Scientific research units in military industry departments have a full complement of specializations and many people. The S&T achievements they have made over many years are retained in their units because of secrecy and other reasons. Enterprises have never been

able to utilize, digest, and produce them. During the process of shifting from military to civilian production, many military product achievements can enter markets, fill in blank spaces, and create wealth for the people with minor revisions. Only by closely integrating with their own specializations and technical and equipment advantages and under conditions of similar techniques, similar technologies, and suitable marketing avenues can military technology be transferred to civilian products to create models for civilian product development and develop superior quality products.

For example, the No 1 Department has design rights and design experience for pressure vessels. Its S&T personnel utilized their special skills and noted that there were no small portable oxygen respirators and that the market was extremely broad, so they immediately organized to develop a "Beijing Brand" medical oxygen respirator. Because of its small volume, large gas capacity, and easy portability, when it was placed on the market it was welcomed by emergency stations, hospitals, the military, retired cadres, and sick people. This product received a "Gold Dragon Award" issued by the State Economic Commission for superior new products in 1985. It passed ministry-level appraisal by the Ministry of Aerospace Industry in 1986 and was included as a fixed-point production product variety by the State Central Pharmaceutical Administration Bureau. They have sold over 7,000 oxygen respirators in past few years and they have been well received by users.

Fostering their own technical advantages also led to: 1) Technical personnel took full advantage of their own technical skills by doing good work on civilian products without abandoning their specializations, which has placed the special technologies of technical personnel in a consistent non-stop state; 2) Fostering technical advantages can lead to fewer twists and turns in civilian product development and enable projects to begin quickly, which helps development of pillar products and fist products; 3) Fostering technical advantages and developing products has vitality and advanced qualities and the products have relatively strong competitive abilities after they are placed on the market.

V. Work Hard at Civilian Product Development, Establish Pillar Products

During the process of shifting from military to civilian products, the question of whether their products have or do not have market avenues is the basis for the existence and development of enterprises, and product development is the primary link. The things that the No 1 Department required for developing civilian products over many years of practice are:

1. Scientifically organize product development, establish effective work procedures

To be able to produce their own products, achieve success in developing projects, and be acknowledged by society, merely having enthusiasm for work and understanding technology are not enough. They can be effective only if they also have a scientific attitude. This requires, first, systematic development of products to ensure that each product has unique functions and can be linked with other products into a series to meet the requirements of all types of users. Second, they should focus on the time efficiency of product development and place items that have been successfully developed into operation as quickly as possible.

2. Products that are developed must have a specific technical height

The reason is that if military industry enterprises only develop and produce regular civilian products, they may compete unnecessarily with local enterprises because of costs, work time, amounts, production scale, and other factors. Military industry enterprises should utilize their own personnel, scientific research, technology, equipment, and other advantages to begin from a "high starting point" in developing products which are available in foreign countries but unavailable in China and fill in blank areas in our country. They should utilize their advantages to renew and transform equipment in large enterprises, reduce state imports, and try to solve technical problems in local enterprises. This eliminates worries and solves problems for the state, conserves foreign exchange, and takes advantage of the technical levels of S&T personnel. For example, the No 1 Department successfully developed a "boiler feedwater pump minimum flow rate control device" and testing instruments for a power plant that solved the problems of usually having to import this type of device from foreign countries at very high prices. This saved substantial foreign exchange for the state and was somewhat innovative technologically. It filled in a blank spot in China. The price of each device was only about 50 percent of the import price and it was included as a power station matching project by the State Machinery Commission and Ministry of Water Resources and Electric Power in the Seventh 5-Year Plan. They have outfitted nearly 40 of the devices at power stations in various locations for a sales volume of more than 5 million yuan.

3. Establish fist and pillar products, avoid blind development

In market competition, military industry enterprises certainly must form several types of fist and pillar products based on their own technical advantages and avoid blind development because when enterprises blindly change the direction of their products during development, it often means that they must abandon their original equipment, production technology, and markets, thereby making all subsequent management entirely ineffective labor. Fist and pillar products are like a base area. They can give military industry enterprises a foundation for continued development, expansion, and conversion into series products, and military industry

enterprises usually can maintain certain economic benefits. Through several years of practice, the No 1 Department has gradually formed fist products which have medical instruments and equipment, food machinery, power station equipment, computer CAD/CAM, and so on as pillars. This enables them to provide a constant flow of products into the market and solves problems in the enterprises, and it enables the No 1 Department to maintain a specific amount of income.

4. We should integrate short-term benefits with long-term benefits

When they are just beginning to develop civilian products, all units usually focus only on short-term benefits and develop and produce several products that offer good benefits now and short- term results. To work on civilian products over the long run, however, they must actively develop new products and integrate short-term benefits and long-term benefits to form steps of products now in production, products now being developed, and products planned for development. Besides basing themselves on their own technical strengths and technical advantages and doing full surveys of market demand to develop many types of new products, military industry units also should organize specialists to consider long-term development directions and development goals, gradually form civilian product projects having several fixed specializations as their foundation, begin working on new products every year, and develop new items every year.

VI. Reinforce Planning Work, Do Good Scientific Management

In civilian product development and production, to provide the products and technical items they have developed themselves with a stable foothold in the market and put them into a fail-safe position, they also should reinforce scientific management of technical debate systems, plan management, information management, quality management, and other lines of work.

1. Fixed technical debate system. This system is a technical guarantee for large-scale projects and major topics and projects in civilian product development. Reliability debate, technical program debate, and economic benefit analysis debate must be organized and carried out for big projects and major topics. Expert colleagues make appraisals at debate and appraisal meetings and report to higher authorities for approval. This system can guarantee fewer errors in project implementation and attain the goals of new programs, using fewer materials, and high benefits.

2. Reinforce plan management work. Because civilian products establish their own guidance and dispatching system, all civilian product projects carry out plan management according to the time limits of contracts. Do a breakdown moving backward from the time for final turnover stipulated in a contract to formulate a plan and prepare a system diagram for time periods, tasks, personnel, and items and use this as a basis for assigning plans. Companies assign civilian product implementation plans on the basis of this system diagram and offices arrange schedules for completion of tasks on the basis of this system diagram. Plans are obviously especially important for large-scale projects.

3. Do good information management work. During the process of developing and producing civilian products, if we want to quickly extend new items and new products that we have developed, we must rely on the method of periodicals, news, and propaganda. Over the past several years, the No 1 Department has published nearly 450 abstracts in various newspapers and magazines in China. As a result, many regions and units admire and seek out the No 1 Department in a desire for long-term cooperation and technical cooperation. If we want to do even better in developing civilian products, we must participate in technology exchange and trade fairs, visit all sorts of international exhibitions, and participate in various types of information networks, special professional societies, and various other channels to collect information to facilitate establishment of projects and development of new products.

4. Do good quality management work. Quality management is a key link in civilian products because product quality directly affects a unit's reputation, affects the personal interests of the state and the people, and determines whether or not a product can gain a foothold in markets and continue to develop. We must apply military product quality management methods in developing civilian products based on the characteristics of civilian products to formulate a quality management system for the entire process of debate, design, production, matching, installation, debugging, and post-sales services so the products produced can pass examination and acceptance by quality management departments and receive certification of meeting specifications. Examination and acceptance of large projects must be done according to the method of self-inspection first, self-inspection again, and finally joint inspection and acceptance by both parties so that the quality of all products turned over to users is guaranteed and users can rest assured.

VII. Implement Contractual Responsibility Indices, Establish an Award System

In the past, military industry enterprises were "accustomed to eating the emperor's grain and relying on average rewards". During the reform process, if we want to destroy the bad habits of asking higher authorities for money and distributing average bonuses, we must implement a contractual responsibility management system centered on profits.

At the beginning of each year, the No 1 Department formulates gross income and gross profit indices for that year according to the value of output and profit indices for civilian products assigned by the First Academy in conjunction with the situation in completing civilian product tasks during the preceding year and then

increases value of output and profit indices by 10 to 15 percent as appropriate. It then divides up these overall indices by levels for each research office according to the situation with personnel structures and proportions and the situation in the amount of work on military product tasks. After full discussion and coordination, the offices formulate civilian product plans for their own offices according to the indices assigned to each office. This provides clear goals for all levels in the No 1 Department, facilitates coordination of all forces, and destroys the traditional management methods of the past in which military industry enterprises were concerned only with completing production tasks and were not concerned with economic results.

After implementing a contractual responsibility system centered on profits, we also have to deal with the question of allocating bonuses. This is a rather complex question because it must both separate grades and make comprehensive considerations. It must encourage everyone to work on civilian products and generate more income, and it must give consideration to personnel who develop military products. It must provide rewards to basic-level personnel and provide income to personnel in organs. For this reason, the No 1 Department formulated documents on bonuses, remuneration, and other issues, stipulated macro principles for allocations among the state, collectives, and individuals, and formulated micro principles for payment according to the amount of work to provide comrades who make greater contributions and generate more income with specific rewards.

Conditions, Channels for S&T Transfer Studied

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[Article by Sun Shuling [1327 3219 3781] and Wu Yongqing [2976 3057 3237] of the Economic Management Department, East China College of Engineering: "A Discussion of Mechanisms for Transforming S&T Achievements." This article is a thesis contributed to "Theoretical Ideas on Reform of the S&T System."]

[Text] **Abstract**

Mechanisms for transforming S&T achievements refer to interrelationships among the various links in transformation of S&T achievements, coordination of their roles, and transformation to normal operation. This article analyzes conditions and motive forces for transforming S&T achievements, patterns and channels for promoting transformation, and other areas to discuss operational mechanisms for transforming achievements.

In brief, transforming S&T achievements refers to extending and applying S&T achievements. Before they are used in the realm of production, S&T achievements are merely forces of production which are in a state of knowledge and latency. To transform them into direct forces of production, there must also be management organs and utilizing units to extend and apply the achievements. This process is called transformation.

I. Motive Forces in Transforming S&T Achievements

Science and technology are the most active and decisive factors in the forces of production, powerful motive forces in promoting economic development, and important fountainheads for increasing labor productivity. In the world's developed nations, 60 to 80 percent of improvements in economic development and labor productivity were achieved by relying on S&T progress. The 13th Congress of the CPC Central Committee clearly pointed out that accelerating S&T development and application should be placed in a primary position to truly shift economic construction onto the track of relying on S&T progress. This requires that we accelerate development of S&T and promote transformation of S&T achievements.

For a long time, S&T achievements in China have been provided free of charge by scientific research units. Administrative departments have an obligation to extend them and production enterprises utilize them without compensation. This method means that scientific research work lacks vitality, S&T system operational mechanisms are rigid, and no mechanisms for transforming S&T achievements have taken shape, which severely restricts development of the forces of production. As economic system and S&T system reforms proceed, enterprises must continually improve results and carry out extensive expanded reproduction. Moreover, reforms in the S&T allocation system place pressures on scientific research units. This creates internal requirements for technical progress in enterprises and makes scientific research units want to orient toward economic construction, thereby forming a true motive force for transforming S&T achievements.

II. Conditions for Transforming S&T Achievements

In acknowledging the role of converting S&T achievements into commodities and acknowledging the role of the law of value in extending S&T achievements, the opening up of technology markets is particularly important for providing favorable conditions for transforming S&T achievements. Reforms in various systems in China at the present time are unmatched and imperfect and technology markets have not developed in a mature fashion, so the socialist unified market has not taken shape and much work is done on a "two-track system." This makes transforming S&T achievements difficult and complex. For this reason, we must conscientiously analyze the internal conditions and external environment for transforming S&T achievements, take full advantage of beneficial conditions, change unfavorable factors, and accelerate transformation of S&T achievements.

1. Transformation of S&T Achievements Should Be Adapted to the Need To Develop the Forces of Production in China at the Present Time

The report of the 13th Congress of the CPC Central Committee pointed out that China is now in the initial stages of socialism. The level of our forces of production is low and the development of our economy and technology is unbalanced. The structure of our production technology is such that high technology, regular technology, and manual technology coexist and there are substantial technical differences among military industry enterprises, new industries, medium and small enterprises, and township and town enterprises. There are also substantial differences in the regional structure between east and west China, coastal areas and the interior, and cities and townships and towns. For this reason, the S&T achievements that should be transformed, first, should be adapted to the need to develop the forces of production in China at the present time and, second, should consider the different levels of the forces of production in each region, the production capabilities of each type of enterprise, and the need for gearing transformation to the capacity for assimilating new technologies. They should also be adapted to the requirements of China's readjustment in industry structures and technical transformation. Only in this way can transforming S&T achievements increase labor productivity, raise the level of the forces of production, and promote development of the national economy.

2. Improve the Maturity of S&T Achievements Themselves, Do Good Intermediate Testing Base Area Construction, Reduce the Risk to Enterprises From Adopting New Technologies, Increase the Feasibility of Using S&T Achievements in Production

The maturity of S&T achievements refers to whether or not an S&T achievement is in the initial completion stage, the intermediate completion stage, or the final completion stage and whether or not it can reach the extent required for immediate utilization in production. Some R&D achievements are not hard or mature enough. After they are applied in production, the failure to take time periods or other factors into consideration can mean that technical parameters are unstable, which will make enterprises apprehensive when they buy a technology.

Because of the gradual separation of ownership rights and administrative rights and implementation of contractual responsibility, leasing, shareholding, and other patterns, enterprises must make their own administrative decisions, be responsible for their own profits and losses, and decide on the size of employee incomes and welfare based on the enterprise profit situation. As a result, all enterprises, especially medium and small enterprises, are usually unwilling to take significant risks in adopting new technologies. Because of their limited capital and small economic strengths, if they fail it is hard for them to compensate for their losses and the managers must compensate for the losses. Thus, to stimulate enterprises to adopt new technologies, development organs should reinforce research on applying S&T achievements, establish intermediate testing base areas (statistics show that over 50 percent of China's scientific research units lack intermediate testing base areas and experiment measures, which is one of the main reasons that technical commodities are immature and not matched up and that effective transformation cannot be achieved), work on "experimental plots," provide demonstrations, make production technology and production techniques advanced, rational, stable, reliable, and adapted to batch production, increase the maturity of achievements, reinforce the feasibility of applying S&T achievements in production, unify understandings of decisionmakers at all levels inside and outside of enterprises, and make a firm decision to adopt new technologies. If the "experimental plots" of R&D organs are solid, intermediate testing is successful, and they can achieve real economic benefits, S&T achievements will have enormous attraction for enterprise production.

3. Reform the Scientific Research System, Reform the S&T Allocation System, Shift Work in Scientific Research Units and R&D Organs From Planned Research to Scientific Research Management

Traditional research on scientific research topics is done by having governmental S&T departments or administrative departments make allocations, select topics from abstracts, and select projects, or by S&T planning departments assigning directive-type tasks. It is not oriented toward economic construction. To change this current situation, we must reform the traditional scientific research system and S&T allocation system. Scientific research organs should gradually establish a guiding ideology of orienting toward production and using market demand as a guide, begin with actual needs in enterprises, start with solving problems in production technology, develop technologies useful to enterprises in technical transformation and equipment automation, formulate management strategies, select topics using administrative concepts, provide suitable market outlets for S&T achievements, continually provide society with competitive technical commodities, and promote a transition in scientific research work from "planned research" to "scientific research management" to promote transformation of S&T achievements.

4. Formulate Comprehensive Examination Indices for Enterprise Contractual Responsibility Managers To Increase Conscious Purchasing of S&T Achievements by Production Enterprises

Implementation of an enterprise contractual responsibility (or leasing) management system in recent years has led to individuals or collectives assuming contractual responsibility for many enterprises. Because the time limits of contractual responsibility are short, many plant managers or general managers exhibit short-term behavior in the management process. They are concerned only with short-term benefits and devise ways to focus on issuing bonuses, building buildings, and adding

equipment that provides quick success and instant benefits. Moreover, because adopting new technology may not generate economic benefits for an enterprise within the short run, and because existing production organizations and structures must be changed and old production relationships changed during the adoption process, the interests of many people are affected. Added to the widespread lack of strict indices for examining technical progress in the contractual responsibility (or leasing) contracts of plant managers, general managers, and other administrators, they use very little capital for technical progress and equipment renewal (technical development expenditures in enterprises account for just 0.2 to 0.3 percent of the sales volume, whereas this figure in foreign enterprises is over 5 percent). Enterprises have no motive force or strength to adopt new technology in the subjective motivations of contractual responsibility administrators and capital. For this reason, when the government is perfecting enterprise management patterns, it should formulate several comprehensive indices for examining administrators to make enterprise managers establish a correct management viewpoint and strategic goals for long-term development so that they are not concerned only with short-term economic benefits and are concerned with renewal and transformation of enterprise equipment and faster depreciation so that enterprise managers integrate short-term benefits with long-term benefits to increase the conscious adoption of new technology in enterprises.

5. Increase the Matching Qualities of S&T Achievement Applications

In applying S&T achievements, an organizational problem of integrated matching exists for the related S&T achievements and production technologies. Many enterprises are quite enthusiastic about importing production lines from foreign countries and are unwilling to purchase Chinese-made S&T achievements. A major cause of this is that existing Chinese-made technologies are not matched up and cannot attain production levels. Because of separation in China's systems, we often can only supply a single S&T achievement and cannot provide an integrated and complete production line. This greatly obstructs or affects extension and utilization of S&T achievements and is not conducive to transforming S&T achievements. Thus, work to promote transformation of S&T achievements requires society to organize several project contractual responsibility companies that will work to collect the related technologies, do re-development and re-processing, and enable them to match up.

6. Determining Prices for S&T Achievements and Their Rationality

One important way to transform S&T achievements is to carry out technical commodity trade in technology markets. S&T achievements are a special type of commodity that can undergo several compensated transfers. Moreover, their value cannot be easily determined because of the exploratory qualities, innovativeness, risk, and complexity of scientific research labor. Thus, during the present stage and for a rather long time into the future, prices for technical commodities in China can only implement market regulation and consultation and negotiation by both parties to a transaction. Determination of the actual price of a technical commodity, however, should be based on inputs and outputs of the technical commodity along with consideration of a technical commodity's costs, profits, risk investment, economic benefits it can create for the purchaser, and other factors to try and make its price approximate its value. Because there are no fixed standards for determining transfer prices in technology transactions in China at the present time, however, many irrational phenomena exist in prices for technical commodities. The asking prices of some technical commodities are too high and enterprises are unwilling to purchase them. The prices offered by some buyers in the transactions are too low and the producers of the technical commodities cannot benefit, sometimes to the extent that even average development costs for some items cannot be recovered, so exchange is impossible. This affects transfers of technical achievements and obstructs transformation of S&T achievements. For this reason, we should provide an objective theoretical basis for determining prices for S&T achievements. A general quantitative range should be set that considers the interests of both buyers and sellers so that their negotiated prices are observed.

There is much disagreement now in theoretical circles about setting prices for technical commodities. Some favor setting them according to socially necessary labor time, some according to specific labor time, and others according to output benefits. We feel that prices of technical commodities should be jointly determined according to the specific labor consumption and output benefits in producing technical commodities and should consider the effects of market supply and demand relationships, price payment arrangements, number of times a technical commodity is transferred, and other factors. In general, it can be done according to the following quantized formula:

$$PF = K + \alpha E$$

In the formula, PF represents the basic price range of a technical commodity, K represents the production costs of the technical commodity, α represents the scientific research unit's share of output benefits, and E represents total profits for 3 to 5 years after the buyer of the S&T achievement places it into operation.

Because the producer of the technical commodity wants to profit from the transaction or at least be able to recover his development costs and the buyer of the technical commodity wants to achieve his profit goals expected from buying the technology, determination of coefficient α is the key to price negotiations. Practice and experience indicate that α is roughly between 0.1 and 0.2. This price is rational if both the buying and selling

parties have consulted, the seller is willing to transfer, and the buyer is capable of accepting.

Moreover, we propose that achievement offices in S&T commissions at all levels or the corresponding administrative organs in each region should formulate an overall standard for technical achievement prices in each industry on the basis of summarizing practice and experience in technology trade, and that they organize experts in all industries to establish authoritative S&T achievement price arbitration organs in all areas to solve problems with irrational prices set during technology transactions.

7. Increase Enterprise Capacity for Assimilating New Technologies

During the process of transforming S&T achievements at the present time, enterprises have a low capacity for assimilating new technology. This is also an important factor which affects transformation of S&T achievements. For this reason, we should accelerate personnel circulation, promote rationalization of personnel structures, move more technical personnel toward the first line of production and toward technically weak medium and small enterprises and township and town enterprises, and increase the overall capacity of enterprises for absorbing technology. We should encourage S&T personnel in all institutions of higher education and scientific research and development organs to move about freely, hold dual appointments and work in their spare time, allow S&T personnel to resign and take leaves of absence, and allow large numbers of S&T personnel to move out of scientific research departments with many talented people into enterprises with shortages of skilled personnel and onto the first line of production, and even encourage them to take up leadership, contractual responsibility, and leasehold management in medium and small enterprises and township and town enterprises, and thereby increase the capacity of enterprises for assimilating technology.

8. Accelerate Integration of S&T With Finance, Put in Credit Mechanisms, Provide Reliable Capital for Transforming S&T Achievements

Capital is an indispensable condition for promoting transformation of S&T achievements. Technology can become new forces of production only when integrated with capital. In technical commodity transactions at the present time, the capital foundation is a major problem. To accelerate transformation of S&T achievements, we must accelerate integration of S&T with finance, put in credit mechanisms, establish S&T investment banks, establish special S&T loan funds, and enable enterprises with inadequate financial resources to adopt new technologies by borrowing.

9. Establish a Perfect S&T Achievement Information System

Establishing an S&T achievement information system can provide a reliable basis for decisionmaking by both buying and selling parties for S&T achievements. Because S&T achievements are characterized by aging due to rapid renewal and replacement, S&T achievement management departments and intermediary organs which administer technology transfers should immediately and quickly adopt modernized measures, do good work in collecting, processing, and transmitting information on both supply and demand, and shorten the time required to apply S&T achievements in production and construction in order to transfer S&T achievements quickly and effectively and obtain economic benefits.

10. Organizational Guarantees for Transforming Achievements (Management Organs and Intermediary Organs)

Development of the socialist commodity economy requires transforming S&T achievements into commodities. Accelerated transformation of S&T achievements also requires adopting the corresponding organizational measures. Thus, we must reinforce management of technology markets and integrated scientific research and production bodies, and provide organizational guarantees for the smooth transformation of S&T achievements. In the past, S&T management departments only had administrative and managerial functions for S&T development. Now, however, besides managing S&T development work well, they also should add new organs like technology market management offices, S&T development centers, and so on to transform technical commodities.

Intermediary organs are the bridges between supply of and demand for technical commodities, so they have an especially important status. Transformation of S&T achievements, especially buying and selling technical achievements, is mainly accomplished by technical commodity management service organs which play an intermediary role. The strength or weakness of the intermediary functions directly affects technical commodity transactions. At present, intermediary organs in China are responsible not only for tasks to link up information on technical commodity supply and demand but must also organize technology transaction activities, debate the feasibility of technology transfers, and hold technology trade meetings. Some must also organize secondary development, organize personnel training and circulation, assist with S&T loans and capital raising, organize complete technology projects, participate in various technical economics integration bodies, and promote a true shift of S&T achievements toward production. For this reason, we must reinforce construction of intermediary organizations and organs and provide them with policy supports like short-term exemption from income taxes on intermediary income, and so on. We must also provide the necessary capital support for certain intermediary organs, increase their capacity for development and intermediate testing, and make it possible for achievements by civilian research institutes and individual researchers incapable of intermediate testing

to achieve immediate extension, application, and transformation into forces of production with help by intermediary organs.

11. Perfect Management Laws and Regulations, Adopt Preferential Policies in Taxation, Pricing, and Other Areas, Create a Suitable Social Environment for Faster Transformation of S&T Achievements

At present, Chinese government S&T management departments and technology markets run by civilian S&T groups lack a unified management system. S&T departments and economic departments are powers unto themselves that lack unified coordination and comprehensive management. This makes integration of S&T and production more difficult. Added to the lack of matching system reforms and absence of concrete and effective supporting policies and methods to support integration of S&T and production, a relaxed social environment has not been formed. Thus, we should work now to formulate and perfect management laws and regulations for technology trade, carry out unified management of technology market activities, and organize integrated scientific research and production bodies. At the same time, we should formulate effective supporting policies and measures in taxation, pricing, credit, and other areas for enterprises which adopt new technologies. In taxation, for example, an enterprise can be exempted from income taxes until it recovers its investments in a technology. In pricing, better prices for better quality can be implemented to enable enterprises to earn higher incomes from adopting new technologies and motivate their initiative to buy technical commodities and accelerate the formation of a "buyers' market."

III. Arrangements and Channels for Promoting Transformation of S&T Achievements

A. All Levels of Government Can Adopt Administrative Measures or Directive Plans To Organize Extension Groups To Extend S&T Achievements in All Regions in a Gradual and Planned Manner

S&T achievement management departments at all levels can ask experts to select and evaluate projects which can be completed quickly, accomplished without problems, and produce results quickly from the projects they examine and approve each year that are relatively technologically mature and reliable, have resources, can earn foreign exchange, and have good product sales opportunities. After feasibility analysis and debate, extension plans can be formulated. Extension groups can be organized first and supplemented with administrative measures for extension and fixed-schedule inspection, and units or individuals with obvious accomplishments in extension can be rewarded.

B. Adopt Flexible and Varied Technology Trade Arrangements, Carry Out Transfer of S&T Achievements

To promote transformation of S&T achievements, we should promote all-round development of technology trade activities in all provinces. Under guidance by the state's principles of "opening up, invigorating, supporting, and guiding" and "administration by many parties, centralized management," provincial science and technology committees should organize mutual study and learning from the experiences of others, encourage individual, collective, and civilian organs to administer technology trade and organize several large technology trade fairs and technology bidding meetings, unify management policies in management of technology trade, and organize forces to train and examine technology trade agents. Technology market deployments can use regular technology markets, circulating technology markets (based on the characteristics of S&T achievements that travel to targeted regions for exhibitions and sales), communications-type technology markets, and broadcast-type technology markets.

C. Reinforce Integration Between Scientific Research Units and Production Enterprises

Integration between scientific research units and production enterprises refers to forming organic entities by scientific research organs and production enterprises to achieve a predetermined goal. This type of integration can directly tie together several links in scientific research, trial development, and production, reduce the schedule from scientific research to production, and accelerate the process of transforming S&T achievements. At the present time, these forms can be adopted to integrate scientific research and production: 1) Scientific research units can be the primary party in forming integrated vanguard scientific research bodies; 2) scientific research institutes and plants can make joint investments to establish enterprises and organize technical economic entities; 3) scientific research units can become scientific research management entities; 4) R&D organs can enter enterprise groups; 5) full-project contractual responsibility companies; 6) scientific research units can lead or assume contractual responsibility for enterprises, and various other forms.

Integration of scientific research with production in China has developed very quickly in the past few years. It has taken many forms and involves considerable numbers. Many problems exist, however, the main ones being:

1. Large and medium-sized enterprises have weak vitality. Large and medium-sized enterprises have widely implemented a plant manager responsibility system for nearly 4 years now which has basically solved problems related to administrative authority, but property representation questions in enterprises have not been truly solved. The provisional viewpoints and local interest viewpoints of plant managers have not basically changed. Because steps toward reform have been difficult in production materials markets and capital markets, and in prices, materials, and taxes, the idea of competition is still weak in most enterprises. These problems directly affect integration of scientific research with production.

2. Management systems are disorganized. Work to integrate scientific research with production directly concerns work by government economic departments and S&T departments. Coordinating these two departments and promoting integration is now a problem which urgently requires solution.

3. There are management problems in new integrated organizations. New organizations to integrate scientific research and production are a type of horizontal integration. Some cross over department boundaries or regional boundaries. Formulation of new management regulations and laws is essential.

4. There are problems in scientific research organ capabilities and readjustment. Scientific research organs which are now independent and outside of enterprises have different levels of scientific research and technical development capabilities. Many research institutes have poor capabilities and low levels. Some do not even have the technical strengths of enterprises. As a result, many scientific research organs face new readjustment problems.

To deal with these problems, we propose adopting the following countermeasures to accelerate integration of scientific research and production.

1. Utilize administrative and managerial measures. This mainly refers to the administrative role of government, which is expressed in the following areas:

a. Relevant government departments such as science and technology commissions and professional departments in all industries should formulate and promulgate technology policies, propose basic goals to be attained in each realm of technology development, basic steps in technology development, and technologies that should be discarded. The goals are to "coordinate the direction of technical activities in each different realm, distinguish the importance and urgency of certain departments and specialized work, readjust their direction, and expand or restrict their scale of development." In this way, scientific research units and production enterprises as well as financial organs will have unified guidance for technology policy which is essential for concerted efforts to do good work to integrate scientific research with production. For this reason, state technology policy plays an extremely important role in guiding integration of scientific research with production.

b. Use the effects of economic measures (taxation, financial subsidies and aid, allocations, bank interest rates, and so on) to guide the direction of technology research and utilization. The government has gradually eliminated scientific research activity expenditures over the past few years to make scientific research units shift their attention toward compensated transfer of S&T achievements and establish organizations for various types of technical and economic integration with enterprises.

c. The government uses its own normal activities (such as plans, instructions, notices, approval or denial, and so on) to carry out administrative intervention in certain technology research projects and the utilization of certain technologies. Make full use of technology policy, financial measures, and certain administrative restrictive or encouragement methods to promote integration of scientific research and production.

Use administrative intervention to organize integrated scientific research and production bodies with rather good foundations into integrated scientific research and production enterprises focused on technical R&D. Implement single listings for the plans, materials, credit, foreign exchange, and other areas for this type of integrated enterprise and implement preferential policies in the areas of finance and taxation for a specific period.

2. Utilize legal measures. Law plays a role mainly in three areas. One is safeguarding and integrating the legal rights of both parties and protecting normal order in the integration of scientific research and production. The second is restricting improper integration that violates laws or regulations or damages the interests of the state or the common interests of society. The third is measures to ensure policy implementation. We propose the formulation of "Regulations for Integrating Scientific Research and Production" which stipulate the principles of integration, the form of integration, the conditions and basic rights, duties, and obligations of participating units, management and property jurisdictions in the integration, allocation of benefits, and procedures for dissolving the integration. At the same time, we should also formulate the corresponding laws and regulations on finance, planning, taxation, management, and so on. This would provide a norm and foundation for free integration of scientific research units and provide integration of scientific research units and production enterprises with regulations to observe and laws to rely on.

3. Cities can establish scientific research and production integration enterprise associations or similar organizations to provide professional advice in the area of integration for integrated scientific research and production enterprises.

4. Within development-type scientific research organs, implement contractual responsibility systems and leaseholding systems to encourage S&T personnel to assume contractual responsibility for research offices or research institutes. Research offices or research institutes can also be leased to S&T personnel, which will play a role in strengthening the capabilities of research organs.

Proposal for Developing Electrical, Electronics Technology

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[Article by Du Xiangying [2629 4382 3841] and Xu Shibin [1776 0013 2430]: "Policy Suggestions for Developing Electrical and Electronics Technology"]

[Text] The new generation of electrical and electronics technology is intersecting technology among the electrical, semiconductor, microelectronics, automatic control, and other realms and it is the key interface between electronic control devices and mechanically operated equipment. Electrical and electronics technology can be applied to achieve various alternative forms of electrical energy conversion, optimum operation of traditional electromechanical equipment and systems, and substantial energy and materials conservation benefits.

"Research on Development Strategies for Electrical and Electronics Technology" was a major soft sciences research project established, organized, and conducted by the State Science and Technology Commission in early 1988. This project received substantial attention and support from the State Science and Technology Commission, the former Ministry of Machine Building Industry, the Ministry of Electronics Industry, Huaneng Company, Beijing Municipality, and other related departments. It organized a total of more than 40 units and nearly 60 experts to do research work covering 1 and ½ years. On the basis of surveys and analysis, it extensively, fully, and accurately set forth the necessity, urgency, and possibility of developing electrical and electronics technology in China, debated development strategies for electrical and electronics technology in China and other important issues, studied technology policy and related policies, and clearly proposed the basic concept that "a major effort to develop electrical and electronics technology to achieve substantial energy conservation is the most economical and realistic form of energy resource construction in China at the present stage." This topic passed formal appraisal and assessment in October 1989. This research project received attention and good evaluations from the relevant departments and specialists in China and it is now being used as an important reference for formulating the Eighth 5-Year Plan. Now, it is extremely necessary that "Policies for Developing Electrical and Electronics Technology in China" be formulated quickly to create an excellent environment as an active guide for development of electrical and electronics technology in China. For this reason, we want to offer some analytical views and suggestions for electrical and electronics technology policy based on this research topic.

I. The Importance of China Developing Electrical and Electronics Technology

A. Reduce energy consumption levels, conserve electric power, reduce China's energy resource shortages. The concurrent existence of an energy resource shortage and high energy consumption is an important restricting factor that is perplexing development of China's economy. Based on analysis of our national strengths, it will be very difficult to make basic improvements in our severe energy resource shortage simply by relying on new energy resource construction and development for a substantial period into the future. Electrical and electronics technology is far superior to conventional energy conservation measures. The main tasks in developing electrical and electronics technology are to reduce energy consumption levels in China and achieve substantial energy conservation. This can reduce China's energy resource shortages significantly.

B. Promote transformation of traditional industries, raise equipment levels. Mechanical equipment which uses electric motors as a power source accounts for a large proportion in our national economy. Technical levels of machine tools, pneumatic equipment, water pumps, sets of mine extraction and freezing equipment, harbor hoisting and haulage equipment, sets of rolling mill equipment, locomotive traction equipment, and other products are determined to a substantial degree by levels of electrically controlled electrical drive systems. This is an important discrepancy between China and the developed nations. Actively adopting a new generation of electrical and electronics technology to transform the backward situation in China's traditional industries is an important measure.

C. Reduce imports and expand exports of electromechanical products, increase the technical content of export products. Electromechanical integration is an important direction for transforming electronic technology in traditional machine products. Because of system and many other factors, sets of electronic devices for China's machine products have developed slowly, which has led to importing large numbers of complete units and large-scale matching equipment and to a passive situation of exporting cheap common machine products. Thus, it is very important that we make a major effort to develop electrical and electronics technology and greater integration of machines and electronics to promote increased grades and replacement of machine products, improve product structures, expand exports, and raise the grade levels of products and technologies.

II. Levels of Electrical and Electronics Technology Policies and Industry Development

Electrical and electronics technology development policies should be composed of three main parts. They are macro policies, micro policies, and auxiliary policies.

Macro policies: From the perspective of development strategies for electrical and electronics technology in China, focus on elaborating the status and role of electrical and electronics technology in development of China's national economy and in medium and long-term deployments and so on, use it to guide the formation of high technology industries in this realm, and establish a macro environment to provide data for policymaking departments.

Micro policies: Consider the development of technology itself to determine the development realms and technical levels we should move on first, formulate development goals for all realms and the related single-item technologies, and serve attacks on key technical problems and the organization of production in scientific research and production departments.

Auxiliary policies: Create an excellent external environment, provide the required guaranteeing conditions for developing electrical and electronics technology, continually reinforce technical reserve strengths, and achieve stable and healthy development of electrical and electronics technology.

Development of the electrical and electronics technology industry should adhere to the following principles:

1. Establish an integrated industry system that includes materials, components, devices, and complete products, be concerned with synchronized development and perfection of supporting conditions and related technologies, gradually form a specialized multi-level industrial structure with a clear division of labor.

2. Readjust existing industry structures and product structures, be concerned with developing the new generation of electrical and electronics technology and products, encourage microelectronics enterprises with insufficient tasks to shift toward developing and producing investment-type electronics technology products and foster the benefits of imported lines.

3. Change operating mechanisms, gradually establish industry groups, form several integrated technology-industry-trade economic bodies. The groups should be formed naturally in competition through integration or annexation with the government selecting the best for support.

4. Establish macro coordination organs to carry out unified planning for the entire process of electrical and electronics technology development and use specific administrative intervention and policy guidance to ensure effective implementation.

III. Component Development and Application Policies

A. Components are the core of electrical and electronics technology and the foundation for industrial development. Technology and industry development should adhere to the principle of moving ahead first with components.

1. Microelectronic technology provides the foundation for the appearance and development of the new generation of electrical and electronics technology. We should be concerned with integrating microelectronics with electrical and electronics technology, pay attention to absorbing new achievements in microelectronic technology, and develop a new generation of electrical and electronics technology.

2. Begin with market demand for different grades of each category and different product series of electrical and electronics components, consider the characteristics and current situation for each, and formulate goals by category and the corresponding policies.

a. Rectifier tubes and crystal gate tubes:

The technology is mature and China now produces them in large quantities. Substantial demand for them in China is expected to continue over the next 10 years. Besides satisfying market demand for these products in China, we should utilize China's rich labor power resource advantages to actively open up international markets by improving technical conditions and product quality and reliability.

b. Turn-off crystal gate tubes, high power transistors, and electrical transistors:

Work on digesting and absorbing imported technology, focus on debugging and operationalizing imported production lines, strive to form a stable production capacity and satisfy domestic demand as quickly as possible.

c. Power field control components:

Use already-imported IC production lines that have insufficient tasks, supplement them with matching equipment, import key technologies, and develop the two large component categories of electrostatic induction transistors and electrostatic induction crystal gate tubes, field control gate tubes, monopolar electrical transistors, vertical conducting metallic oxide FETs, isolation gate pole crystal gate tubes, and insulation grid crystal gate tubes.

d. Power ICs:

Actively develop advance research and technical reserves to open up channels for international cooperation, try to enter the trial production stage for some products during the Eighth 5-Year Plan.

B. Application policies

1. Based on component development, make real-time choices of focal points, limit goals, concentrate forces, and gradually improve applications of electrical and electronics technology. In the short term, we should focus on the different characteristics and levels of each type of component and select focal realms for applying each type.

a. Crystal gate tubes: Make mine hoisting and vehicle traction the key application realms and continue to make major efforts at extension. At the same time, actively develop high-voltage DC power transmission, dynamic reactive compensation, and other application realms.

b. Turn-off thyratron, high power transistors, and electrical transistors: These are mainly used in AC frequency conversion speed-regulating systems. They are an important means for technical transformation in traditional industries and power conservation. They should be the focus of electrical and electronics technology application. There are broad application prospects for high power turn-off thyratron AC frequency conversion speed-regulating devices in electric locomotives and internal combustion locomotives and they should receive sufficient attention.

c. Static induction transistors, static induction crystal gate tubes, and field control crystal gate tubes: These are used as high frequency ballasts in energy-saving fluorescent lights. They are an application realm with substantial development prospects. We can also use China's rare earth resource advantages to form large numbers of new product types to earn foreign exchange. These tubes have special advantages in high frequency induction heating devices.

d. Monopolar electrical transistors, isolation gate pole crystal gate tubes, insulation grid crystal gate tubes: These are mainly used in switching power sources, vehicle electronics, uninterrupted power sources, and other realms. Using them in AC and DC servo systems can provide lighter weight and more precise numerical control machine tools, industrial robots, and so on.

2. Application of electrical and electronics technology should be aimed at projects with major effects on the national economy and providing needed electric control devices and systems for important sets of technical equipment. Develop products with large numbers, broad ranges, and obvious energy-saving benefits to increase social and economic benefits.

IV. Scientific Research and Development, Technology Imports

A. Organize forces for concentrated attacks on key problems. Truly focus on research on key basic electrical and electronics technologies, arrange work according to the three levels of basic research, applied research, and development research and according to unimportant and important, non-urgent and urgent.

B. Reinforce construction of testing base areas, establish state laboratories, open them to society, serve the entire industry.

C. Focus on everything using an integrated pattern of "applied research—product development—intermediate testing—production and manufacture—extension and application," strive to turn mature technologies into commodities as quickly as possible, and move them into markets.

D. Focus on importing technologies which are in short supply and a new generation of key components, actively develop related matching products, ensure the formation of new forces of production.

E. Adhere to the principle of focusing on self-development, continually raise technical starting points and import grades by assimilating imported technologies.

F. Break down "factional concepts," immediately organize all industry forces to assimilate imported technology, achieve single importers and full-industry benefits.

V. Capital Raising, Investment Directions, Import and Export Management

A. In the initial stages of creating the new generation electrical and electronics industry, the state provides "sufficient starting capital" to support technology and industry beginnings. Afterwards, the capacity of the industry itself for regenerative increased value is used to gradually accumulate capital and enter a benign cycle.

B. Establish key product development funds and energy-conserving interest deduction loan funds to encourage development of key electrical and electronics products.

C. Establish special foreign exchange funds to purchase complete sets of typical devices (used for dissection and digestion) and the necessary components to support development of technology-intensive products.

D. Provide electrical and electronics technology development insurance and credit services, have insurance companies and enterprises bear joint responsibility for the investment risks in new product development and application.

E. Resolutely attack and suppress behavior involving long-term importing of parts for assembly to earn profits from foreign exchange price differentials under the name of "technology imports" and "cooperative production."

F. For all imported complete sets of equipment or entire machines that contain new types of automatic control devices and systems, time limits should be stipulated for assembled components requiring that they attain levels of domestic production to make them an organic part of China's industrial system and eliminate long-term restrictions on us by foreign enterprises.

G. Suitable price subsidies should be provided during the initial stages of trial marketing and application for new types of electrical and electronics products which have just begun. Funds for these subsidies can be provided by requisitioning import added taxes for similar products (including components shipped in for processing). As the functional price ratio for Chinese-made electrical and electronics products gradually rises, the price subsidies and import added taxes should be reduced gradually each year and eventually eliminated simultaneously.

VI. User Encouragement Policies

A. "Penalize the old, subsidize the new." Charge high taxes on old backward products that consume substantial energy as an "interest deduction loan fund" for energy-saving products and subsidize users. Encourage users to apply new electrical and electronics products to carry out technical transformation.

B. Establish an "energy conservation technical transformation fund" to provide preferential loans to users and enterprises, use expenditures on energy-saving electrical and electronics technology in enterprises to repay the loans and include them in costs.

C. Energy taxes paid to higher authorities by enterprise and business units should be linked to actual energy consumption to encourage energy conservation.

VII. Personnel Training Benefits

A. Focus on selecting a few institutions of higher education to establish electrical and electronics specializations for planned personnel training. Continue to focus on training Masters' students, Ph.D. students, and other advanced personnel in specializations with electrical and electronics orientations. Gradually expand the scale of training according to developments in electrical and electronics technology.

B. On the basis of the requirements for developing the new generation of electrical and electronics technology, readjust existing curriculum deployments for electrical and electronics specializations and add content for the new generation of electrical and electronics components and new developments and applications of modern control theory.

C. Develop on-the-job training in a planned manner for employees to supplement new knowledge immediately, continually improve the professional qualities of technical workers.

D. Be concerned with importing intelligent personnel in the area of electrical and electronics technology, reinforce international scholarly exchanges, maintain relationships with relevant world bodies and units with relatively strong technical strengths, adopt the pattern of "sending people out and inviting people in" to focus on solving several key technical problems.

Major S&T Policy Issues To Be Faced in the 1990's Discussed

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[Article by Yang Lincun [2799 2651 2625] and Qiu Chengli [6726 2052 0448]: "Major S&T Policy Issues To Be Faced in the 1990's"]

[Text] With the arrival of the 1990's, S&T development in China is facing new challenges and opportunities. After reviewing China's S&T policies in the 1980's, the experts and departments in charge believe that it would be tremendously significant for our effort to speed up modernization in China if we raise a number of issues and responses without delay based on the characteristics of S&T development in the 1990's.

Guided by the spirit of the 3d Plenum of the 11th CPC Central Committee, the CPC Central Committee and the State Council led the army of S&T personnel in breaking free from the strangle-hold of ultra-leftist thought in the late 1970's and early 1980's and brought order out of chaos. There were major breakthroughs in the acquisition of S&T knowledge. For instance, it was clearly established that science and technology are productive forces and that S&T personnel are part of the proletariat, etc. These breakthroughs in theory and understanding paved the way theoretically and ideologically for the unveiling subsequently of the overall principle of S&T development—"economic construction must rely on science and technology and science and technology must be oriented toward economic construction"—and for the introduction of a range of major S&T policies, including the improvement of the conditions of service for S&T personnel, the mobilization of their enthusiasm, and S&T structural reforms. These important ideas and viewpoints, which crystallized in the early 1980's, prevailed through the entire decade.

On the basis of their research and studies, experts think we have yet to examine the following issues in earnest and arrive at a consensus so that we can put forward a response:

1. How to Implement the Key Policy of "Making S&T Work the Centerpiece of the Economic Development Strategy."

This major strategic measure put forward by the 13th National Party Congress shows the resolve of the CPC Central Committee and State Council to shift from a speed-oriented economic development model to one oriented toward efficiency. This enormously significant strategic shift has yet to be realized. This is mainly because a large number of leaders at all levels do not yet truly understand the colossal role played by S&T progress in economic and social development. Also, since the contributions of S&T progress to social and economic development are multi-level, multi-faceted, and multi-dimensional, the implementation of this strategy is a vastly complex matter. Basic research, technological development, and the development of high-tech industries all take place at different levels. Their work methods are totally different. Regions, trades, and enterprises also differ in their forms of technological progress and S&T demands. Given the existing system, it is a daunting job to make the Chinese economy S&T-based within a short time. It must go through a difficult process. But while the process is difficult, this fundamental strategic shift is inevitable, being determined by the objective laws of economic development. In the 1990's, we should make endless efforts to accelerate the shift.

2. Gradually Develop New Operating Mechanisms for S&T Progress and Make the Most of State Planning and Market Regulation Correctly.

China will follow a socialist planned commodity economy on a long-term basis in future. This determines that both state planning and market regulation will play a role in the nation's S&T progress. Accordingly we must examine in earnest ways of adopting the operating mechanisms for S&T progress. At what levels and within what scope is state planning more suitable than market regulation, and vice versa? What are their respective

strengths and limitations? And how can we integrate and coordinate them organically? At present there is a greater measure of consensus on basic research and public interest-type of research: We believe market demand has no effects on them. Therefore, the state should support these kinds of research. Much more problematic are the respective roles of state planning and market regulation in technological research and development in industries involved in the production of commodities. Where should the two meet in these kinds of research? How should the two be reconciled? Our insufficient understanding on these issues has already affected S&T work today. If this problem remains unresolved, it will make our future work even more haphazard.

3. Clarify the Role and Place of the State, the Industry, the Enterprise, and the Scientific Research Organization in S&T Progress and Their Division of Labor. Allocate and Reorganize S&T Resources Rationally.

As the economy further develops and reform intensifies, gross irrationalities in the structure and allocation of scientific and technical forces are becoming clearer and clearer. For instance, some basic research organizations duplicate one another or are too fragmented. Within the trades, technological development organizations are not working as they should. Overall, there is a surfeit of research organizations, but such abundance is accompanied by a shortage in some areas. The status of private S&T organizations has not been properly established. Nor has their conduct been formalized. The technological development forces of enterprises, particularly small and mid-sized enterprises, are meager. There is also a regional imbalance in technological forces. All these illogical circumstances have resulted in tremendous waste and are no longer compatible with the development of a socialist commodity economy. It will be a long-term and daunting task for the 1990's to properly deploy and reorganize the existing scientific research organizations and personnel through sound policies and measures based on the characteristics of scientific and technological work of research organizations at different levels, in different trades, and under different ownership systems.

4. S&T Progress in Agriculture

The place of agriculture in the national economy is known to all. The state accords top priority to agricultural S&T progress. How to use science and technology to generate a boom in agriculture is a long-term and daunting mission. Since agricultural production is intimately related to natural conditions, agricultural S&T progress is clearly unique. Agricultural S&T embraces basic research, applied research and development, the dissemination of services, and other work at all levels, which no doubt complicates progress in S&T agriculture. For instance, some agricultural S&T projects are highly risky and time-consuming and have a low success rate. Accordingly, they require steady investment and support over a long period of time. Right now there is insufficient investment in agricultural S&T, which is bound to hurt the momentum of agricultural development. Agricultural technological dissemination services involve hard work and are poorly paid, resulting in a high turnover rate among the corps of workers. As agricultural development reaches an appropriate scale, how to create new mechanisms to help science and technology bring prosperity to agriculture, how to establish a new agricultural technological service system and other questions will assume increasing significance over time.

5. Enterprise Technological Progress

The enterprise is the final vehicle of technological innovation. Only through the enterprise can science and technology in the production area be converted into products and profits. Without enterprise technological progress, one cannot even begin to talk about science and technology as an engine of economic development. Nowadays enterprises are not motivated to pursue technological progress. Nor are they under pressure to do so. Therefore, they have little enthusiasm for S&T progress. With limited self-accumulation, enterprises cannot afford sufficient investment in technological R&D. Since intermediate testing is woefully inadequate, scientific research achievements are not converted into productive forces. As yet enterprises are not yet operating on a scale large enough to enable them to take on the risks associated with technological involvement. On the other hand, the state has not been giving effective support to the enterprise's technological pursuits. Confronted with this array of problems, in the 1990's we must experiment with and search for new mechanisms of technological progress in enterprises under a socialist commodity economy, gradually create a policy environment and market environment favorable to stimulating enterprise technological progress, and step up state guidance of and support for such progress. Only when technological progress becomes a major factor of enterprise development can the national economy truly rely on S&T progress.

6. How to Support the Development of High-Tech and New-Tech Industries.

Owing to years' of steady investment, China boasts a S&T army surpassing that of most developing nations and actually matching or approximating advanced world standards in some areas. The development of high- and new-tech industries will be an important means of making the most of our current S&T forces in the service of the national economy. The development of high- and new tech industries in the 1980's proves that there is vast room and tremendous potential for their development. Reform and the open policy have also provided an international market and opportunities for such development. Facts prove that the prospects for high- an new-tech industries in China are bright. Be that as it may, such industries do differ from traditional industries in that they rely more on people and require more flexible operating methods and a more relaxed external environment. What we should do is to review our work in the 1980's and use the lessons thus learned to hammer

out new mechanisms for developing high- and new-tech industries suited to China's conditions, enhance their vitality, intensify the government's macroeconomic management and guidance and accelerate the development of China's high- and new-tech industries.

7. How to Further Mobilize the Initiative of S&T Personnel

In the 1980's a lot of work was done with a measure of success to implement the policy on intellectuals, improve the status and conditions of service of S&T personnel, and mobilize their enthusiasm. This was mainly accomplished by two means. First, administrative methods such as the offering of rewards, evaluation of job titles, and the improvement of wages were used to improve the conditions of service of S&T personnel. As far as objective effects are concerned, although these methods went some way toward solving the conditions of service problems of some S&T personnel, they are of limited use in mobilizing the initiative of S&T personnel. On the contrary, they have fostered the growth of egalitarianism, exacerbating the problem of "eating from the big rice pot" in distribution. The achievements of the 1980's were also effected by such reforms as "double liberalization" and "invigoration." Many S&T personnel, particularly those who joined private S&T research organizations, have seen an improvement in their living standards and status. They did substantial work and had a successful career. This method, which is totally different from the practice of government running everything, has been remarkably successful in mobilizing the initiative of S&T personnel. But it has given rise to a number of problems like unequal distribution of costs and benefits and unequal distribution. The practice of the 1980's shows that while both approaches have worked in their own ways, there are also some problems. As the two approaches will continue into the 1990's, a leading issue we will face is how to make the most of the two approaches fully and sensibly so that they supplement each other harmoniously. Many outstanding people who graduated from college in the 1950's will retire one after another in the 1990's, which may well result in a gap in the ranks of qualified personnel. We should pay utmost attention to this problem and promptly adjust our policy if necessary by continuing to use the services of some outstanding personnel who have retired. At the same time, we must accelerate the training and employment of young people. In the future the professional, ideological and psychological needs of S&T personnel as well as their living conditions must be examined more closely. By using a combination of moral encouragement, administrative measures, economic leverage, and other means, we should gradually establish a body of policies and a social economic climate favorable to unleashing the initiative of S&T personnel.

8. Create a Multi-Level and Multi-Faceted S&T Funding System

Lack of funding is one of the biggest impediments to S&T progress in China. Much useful experimentation was already conducted back in the 1980's in S&T development fund-raising. In the 1990's we must do our best to translate theories and ideas into reality, including the improvement of the management of state investment, S&T loans, venture capital, fund-raising at home and abroad, and overseas loans. All these funding activities must be institutionalized and standardized. Only with the establishment of a funding guarantee system can the S&T enterprise develop soundly.

9. Correctly Handle the Relationship Between the Import of Technology and Self-Development.

This topic was a very controversial one back in the 1980's but has never been fundamentally resolved. In the past 10 years China has imported some technology and equipment, part of which proved to be a big boost to the economy after being absorbed and assimilated. Nevertheless many problems remain. At the heart of the issue is that imported technology is divorced from domestic R&D and even affects and interferes with the normal conduct of scientific research within the country. For its part, scientific research within China has also failed to give the import of technology effective support and services. There are no effective linkages between the two. In short, the import of technology has not turned out to be a major tool of improving China's self-development capacity in science and technology. In the 1990's we must continue to analyze the economic, institutional, and scientific and technical reasons for this and gradually search for a way to combine the import of technology with the enhancement of self-development capabilities.

10. Continue to Create and Improve China's S&T Legal System.

The further intensification of reform and the open policy, the rapid development of S&T, the increasing commercialization and rapid conversion of S&T achievements into products—all this has put forward urgent demands on S&T legislative work. A S&T legal system is badly needed. While notable progress has been made in that area in the 1980's, we must continue to broaden the scope in the 1990's to make full use of law as a guardian and catalyst of science and technology. A number of mature S&T policies and relevant regulations should be improved and upgraded as law. Apart from implementing such S&T legislation as the "Technology Contract Law" and the "Patent Law," we must quicken the formulation of laws and administrative regulations favorable to S&T development and progress and gradually write into law the contents of the training, management, and utilization of S&T personnel.

Financial Strategy to Support High-Tech Industries Studied

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[Article by Wu Lanjun [0702 5695 0689]: "Preliminary Exploration of Financial Strategies to Support High-Tech Industries"]

[Text] The development of high-tech industries has spearheaded the entire national economy. The development of China's high-tech industry has been slow. The reason is not in the lack of technology in the mastering of advanced technology. China is in the forefront in the world in astronautics and nuclear fusion research. In bioengineering and laser technology, research on which began early, China's high-tech industry still produces quite a number of inventions and these are eagerly sought by developed countries, such as the United States and Japan. However, the growth of our high-tech industry and high-tech products represents a small proportion of the national economy, far behind that in the United States, Japan, and other developed countries, and behind Hong Kong, Taiwan, South Korea, and other nations that have not mastered many of the high-tech areas. The reason has to do with obstacles in the present system of financing for science and technology and the basic industries. In addition, China has not established to this date a system of financial mechanism to support the development of high-tech industries. The lack of capital and obsolete administration are major limiting factors in the development of high-tech industries.

1. High-tech industries need strong financial support. High-tech industries require high levels of investment. Without large amounts of capital, high-tech production is nothing more than a mirage. Where then does capital to develop high-tech industries come from? People have searched for a number of channels, such as capital investment, business investment, public investment, and foreign investment among other methods. Of course, these channels of collecting capital have undoubtedly served important purposes in the past. However, careful analyses will show that these channels of financial sources are very limited for the development of high-tech industries in China.

First, there is the financial investment channel. In 1988, China's fiscal income totaled 262.8 billion yuan. However, the total fiscal expenditure was 270.6 billion yuan. The deficit in 1988 was 7.8 billion yuan. If state bonds and borrowings are not included in the income, according to established international methods of calculation, the deficit was almost 30 billion yuan. At the same time, the dynamic picture of national income in China shows a gradual decrease in magnitude. If inflation is taken into consideration, the absolute amount of fiscal income between 1987 and 1988 also showed a drop of several billion yuan. Therefore, in the near future, it is not practical to depend on any large increases in the national budget for investment in high-tech industries.

Second, consider business investment channels. There are numerous businesses in China, and they control large amounts of capital. However, whether it is national or cooperative enterprises, the organizational systems lack autonomy in investment. The operational mechanisms of these enterprises lack motives for taking chances. In addition, most of these enterprises today find it hard to just keep up their flow of capital, and it will be very difficult to invest in other areas.

Next, consider public investment. In comparison with the past, both rural and urban residents possess more liquid assets. Civilian savings have also reached more than 380 billion yuan. However, the average earnings in China are still very low, and there is the lack of a tradition of investment. In addition, the financial institutions in China are still in their developmental stages and therefore cannot provide effective financial investment instruments. Pooling capital from the public will not be workable.

Lastly, consider foreign investment. In developing China's high-tech industry, it already has attracted large amounts of foreign investment. However, beginning in the 90's, China will enter the peak period of debt payments. Whether China is asking for further foreign investment or whether foreign investors desire to invest in China, the approach will have to be more cautious. Also, since last June, a number of Western countries set limits on investments in China. Hopes for great increases in foreign investment are unrealistic.

Since the above-mentioned channels of investment will not generate any large increases, our attention is now forced to turn to the financial arena. Hence, the State Science Commission decided to try it hand at financing in 1985, and organized the China New Technology Development Investment Company. However, experience shows that this kind of institution cannot bear the burden of supporting the development of the entire high-tech industry. The last choice left is: lean on the support of banks, and hope that the national banks can lend support. This hope includes the following three areas. First, it is hoped that banks can provide the investments and loans necessary to support the development of high-tech industry. Second, it is hoped that the reputation of banks and modern finance methods will produce financial break-throughs. Third, it is hoped that with the help of financial information and financial management techniques, the management level and economic benefits of the high-tech industry can be improved.

Is it possible for the banking industry in China to satisfy such needs? Objectively speaking, the basis is there, but the necessary conditions are not all present. As of now, the capital of China's banks is over 1200 billion yuan. Seventy percent of the liquid capital of China's national and cooperative enterprises is supplied by the banks.

Also, supporting the high-tech industry is congruent with the goal of regulating the credit structures of banks. There are over a million employees in the nation's banking industry. Among them there are many who are knowledgeable in finance and are good administrators. The business network of the national banks covers the rural and urban areas of China, linking up with all the industries, and consolidating a large amount of information. These banks have branches or agents in many countries and regions in the world, and keep wide-ranging international contacts. These conditions can provide the development of high-tech industry with a solid foundation. At the same time, the nature of the national banks also determines its unforesakable responsibility in supporting high-tech industry and the resultant development of the entire national economy. However, there are numerous contradictions in China between the financial industry and the high-tech industry today. These contradictions are rooted in the nature of high-tech industry and the traditional financial industry.

2. The specific discrepancies between the financial industry and the high-tech industry. In general, high-tech industry produces technology that is based on the newest scientific achievements. The high-tech industry is one that is highly innovative, speculative, coordinated, and time-constrained. These characteristics are at variance with the way banks conduct business.

Consider the innovative characteristic. The high-tech industry is a knowledge-laden one. It is based on the achievements of the natural sciences. The bank is a financial institution and lacks engineering personnel that understand advances in the natural sciences. At present, there are also no established institutions that are authorities on whether the widespread use of high-tech products is viable. The nature of the banking industry requires that the bank understands systematically and in detail the industries, projects, and the products in which it invests. It also needs to predict fairly accurately the developmental prospects of the projects it invests in or provides loans for. The bank will provide capital for investment in a project only if the bank is fairly certain of the risks. Therefore, the relative lack of engineering personnel in the banking industry is an important reason for the hesitation it displays towards the high-tech industry.

Consider the speculative characteristic. The risks of starting a high-tech enterprise are much higher than those for a traditional one. According to statistics, the failure rate of high-tech enterprises overseas is between 20 and 30 percent. Banks are certainly not inclined to take on such high risks. Because banks are holders of credit, of the operational capita, over 80 percent belong to their clients in the final analysis. They therefore have no right to engage client deposits in speculative adventures. Otherwise, when clients lose confidence and withdraw their deposits, banks will face the fate of certain demise. Therefore, regardless of space or time, banks are extremely cautious enterprises. As American economist Walt Bai-zhi-hao (phonetic) said, "Taking risks is the lifeblood of business, caution to the point of being timid is the lifeblood of banking." The cautiousness in banking and the innovative and speculative nature of high-tech industry are incongruent."

Consider the coordination characteristic. High-tech investments require large sums of money. On the other hand, banks do not invest heavily in one industry or one enterprise because of the above-mentioned characteristic of cautiousness. In fact, some countries have stipulations that banks can only invest up to a certain proportion of the total capital the firm owns. The coordination characteristic of high-tech investment is in conflict with the principle of distributed risks of banks.

Consider the time-constrained characteristic. The high-tech industry has a quick metabolic rate; products and equipment change very rapidly. This means big changes in the business environment to banks. A quick pace is looked upon scornfully by banks. Also, according to current regulations, high-tech enterprises that succeed and achieve profits over and beyond projected goals only reward banks with returns similar to other loans. On the other hand, if the enterprise fails, banks will bear the losses. The administrative personnel will also suffer the corresponding economic, administrative, and even legal responsibilities. The above-mentioned barriers have certainly kept bankers at bay when it comes to loans to the high-tech industry.

3. The real solution to overcome specific discrepancies is to intertwine the two. Specific discrepancies are the problem of coordination of the two main bodies in consideration. To solve this problem, the two bodies must be oriented in the same direction. However, regarding the financial and the high-tech industries, we can neither require that the high-tech industry be in balance all the time, nor can we require that the finance industry take unwarranted risks. A more realistic choice is: the two industries break their own confinements and intertwine. The two can form a symbiotic whole, and based on the collaboration the two can be linked together.

One method of intertwining is the infiltration of the banking industry by the high-tech industry. Research institutes and high-tech departments need to deliver the newest information in science and technology to the banking industry and provide it with engineering personnel. By owning shares and consigning its limited capital to banks, the high-tech industry can seek to quickly combine with the banking industry. The other method is the infiltration of the high-tech industry by the banking industry. This includes providing the high-tech industry with financial experts; investments can be delivered in the form of combined capital, and loans can be offered using credit in order to support the development of high-tech industry. This intertwining should produce the following two results. The first is the mixing of engineering technology and economics to produce a high-tech industry assessment and information unit.

This unit can be called the high-tech information center. The second is the establishment of a bank that possesses substantial capital that can be used in the administration of high-tech industry. This bank can be called the high-tech development bank.

The high-tech information center is the pioneer of the combination of the high-tech industry and the finance industry. It is responsible for the assessment of high-tech projects that are highly innovative, heavy in capital investment, and technologically complicated. The high-tech information center has to appoint experts from the natural sciences, engineering, and finance. The former are responsible for the assessment and evaluation of the ingenuity, the technological feasibility, the flow of production, and the quality of the products. The latter are responsible for the forecast of the life of the products, the marketing, investment, production and other economic indices. The two combined can generate reports on the discussion and conclusion of whether high-tech projects are economically feasible. This then allows projects to be selected, risks to be limited, and can lead to the development of high-tech industry. According to the present situation, the high-tech information center should be led by the State Science Commission. The center employs experts full-time or part-time from research institutes, technology intelligence agencies, patent departments, economic and financial experts. As far as high-tech information is concerned, the most important aspects are the accuracy and authority of the reports; therefore there should only be one such center in China.

The high-tech development bank is a specialized bank that supports development and research in high-tech, merchandizing and applications of high-tech products, and the distribution of their services. It should be a by-product of high-tech facilities and high-tech research areas. The high-tech development bank is responsible for the practical tasks of the investment, loans, and accounting of high-tech enterprises. In terms of personnel, it should be staffed by banking personnel, and in addition absorb engineering and technical personnel to participate in investment and loan decision-making. During times of important decision-making, it accepts directives from the high-tech information center. In order to better utilize the limited capital budgeted for science and technology and that from bank loans, and fully utilize the existing banking network, the high-tech development bank should not establish its own network. It should be spearheaded by the most powerful speciality banks of the participating municipalities. According to the present situation, this can only be undertaken by the Commercial Bank of China. The network is then developed for the high-tech facilities and research areas by the Industrial & Commercial Bank of China at the provincial level. Each of these developments receives directives from the provincial Industrial & Commercial Bank of China.

4. Operation of the supporting system of high-tech industry. Operating the supporting system of high-tech industry means by and large the development of capital procurement and control, product merchandizing and transportation, and the self-sufficiency and development of the supporting system.

The following are several channels of capital procurement.

First, the bank provides the capital. At the beginning stages of the high-tech development bank, the Industrial & Commercial Bank of China should provide loans at a certain amount based on credit, thereby providing a basis for credit capital. The People's Bank of China should also give preferred consideration to the high-tech development bank in terms of fixed loans, specific loans and loans on short notice. In the present situation of tight economics, the amount of capital available from the People's Bank and the Industrial & Commercial Bank is also quite limited. However, the following steps can and must be taken to support the development of high-tech industry: centralize capital for technology reform, use the capital obtained from reorganizing the present credit structure and apply the newly available capital to support high-tech industry.

Second, the high-tech development bank can accumulate more capital in the form of stocks and bonds. Due to the lack of confidence of the business and private sectors in high-risk investment, already established and well-known high-tech enterprises should first be offered for investment in the form of preferred stocks and short-term bonds, and the high-tech development bank can insure and issue them.

Third, develop collaborative enterprises. It is not wise to set eyes on just the amount of currency and capital; it is more important to value the potential of the products. Both the high-tech information center and the high-tech development bank have to exploit their wide networks and abilities to rapidly disseminate information to seek traditional industries with the potential of transformation. In so doing, new technology can be grafted onto the stems of traditional industries. With the use of collaborative enterprising, factories and equipment used in traditional industries can be used to manufacture high-tech products.

Fourth, investment in high-tech industries obtained from financial institutions should be turned over to the high-tech development bank in order to utilize the time and space difference to reap more benefits from the limited capital. Also, the bank can also tap into its international networks to enlarge channels for foreign investment. Linking from within and introducing from the outside, many channels of investment can be created.

As to the utilization of the available capital, the high-tech information center has to participate in the planning, provide general strategies for the development of the high-tech industry and direct the various capital investments made by the high-tech development bank. As the financial support of the development of the high-tech industry, the high-tech development bank has to supply both liquid as well as fixed capital. Therefore,

its operation has to have its own character. It has to engage in traditional enterprises, and at the same time it also has to develop new business such as loans, consignments, and underwriting, in order to develop new areas in financing. It should also be noted that the latter task is the more important one.

In order that the financial support system of high-tech industry can improve and develop, China should provide special policies for the special needs of this industry. In addition to tax reduction, it should be provided with more autonomy. For example, the high-tech information center should have adequate authority to determine fees for its payable services. In addition to regular service fees calculated for the services provided, it should include insurance based on the risks on the project. This is to offset the economic responsibilities it has to shoulder in erroneous decisions. The high-tech development bank should control the interest rates. In the initiation of an enterprise, it can provide investments or interest-free loans. When a project is developing, it can provide low interest loans to support it. When the enterprise is at its prime, it can provide capital with a high rate of return, or offer capital investment or dividends. The bank can also sell stock to obtain high profits for further initiation of projects. In this way of using wealth to support the needy, the bank thus provides protection against risks. At the same time, the high-tech development banks distributed all across China can team up to establish insurance companies to provide protection against risky investments and loans. In this case, when a large-scale project fails, the high-tech development bank involved can seek damages due to erroneous recommendations from the high-tech information center, and obtain payments from the insurance company, thus reducing grave interference to its operation.

In conclusion, the financial organization established to provide financial services to the development of high-tech industry is of a special kind. In order to overcome the specific discrepancies between the high-tech industry and the financial industry, and adapt to its risky initiation environment, this system must include layers of insurance in order to distribute risk, smooth over rough situations, and allow the financial support system of the high-tech industry to operate normally and with stability.

Reform of S&T Fund Allocation System Examined

90FE0210D Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Jun 90 p 1

[Article by Yu Chaoying [0060 6389 5391] and Zhang Zhongbao [1728 1813 1405]: "Reform of S&T Fund Allocation System Makes New Progress"]

[Text] Since its introduction in 1986, the reform of the S&T fund allocation system has proceeded smoothly. As of today 75 percent of technology development institutes subordinate to the ministries and commissions of the State Council have cut spending, 5 percent more than planned.

The reform of the fund allocation system is an important part of the decision of the CPC Central Committee on the reform of the S&T system. The purpose of gradually reducing the scientific operating expenses of scientific research units of the technology development type is not to decrease investment in S&T, but to change the way money is spent and put pressure on these units to orient themselves to economic construction and energize themselves accordingly. Two-thirds of the operating expenses thus saved are returned to the departments in charge to pay for industrial technological work for the scientific research units or on the nation's priority scientific research projects. A new regulation this year also requires that most of the funds (over 80 percent) be returned to the research unit involved through the contract system to give it a fairly steady source of incomes to support technological work or key S&T projects. The remaining one-third goes to the State Science Commission to form a S&T fund from which loans can be made nationwide or to subsidize interest rates on S&T loans. As such, the funds will be spent directly on research units that have cut operating expenses.

According to reports, 17 agencies have succeeded in cutting operating expenses. They are the Ministry of Light Industry, Ministry of Metallurgical Industry, State Building Materials Industry Bureau, Ministry of Railways, China Petrochemical Corporation, China Petroleum and Natural Gas Corporation, China Coal Mining Corporation, China Non-ferrous Metals Corporation, Ministry of Textile Industry, Ministry of Machine Building and Electronics, Automobile Industry Federation, China Building Engineering Corporation, China Tobacco Corporation, Press and Publication Administration, State Technology Supervision Bureau, State Restructuring of the Economic System Commission, and the State Science and Technology Commission. They have been presented with letters of validation and honorary certificates by Vice Chairmen Li Xue [2621 4872 6759] and Zhou Ping [0719 1627] of the State Science and Technology Commission.

Private S&T Foundation Funds Research Projects

90FE0210B Beijing KEJI BAO [BEIJING SCIENCE AND TECHNOLOGY NEWS] in Chinese 16 May 90 p 1

[Article by Zhu Pinghua [2612 5493 5478]: "Private S&T Foundation To Favor Agricultural, Energy, and Basic Projects"]

[Text] Since it begun funding activities 2 years ago, the Zhenhua Foundation of the Chinese Scientists Association, China's first private foundation devoted to financing S&T research projects, has provided a means whereby R&D projects that are scientifically significant

and are urgently needed in national economic construction can be realized. Zhenhua Foundation also furnishes an "arena" where unknown S&T personnel with genuine learning can render services to the motherland.

According to reports, the Zhenhua Foundation decided to fund four projects in 1989 selected from the 10 applications submitted the year before. Among the winners, the "manufacturing technology of laser holographic photosensitive negatives," a project headed by Ma Chunrong [7456 2504 2837], an associate professor at Beijing S&T University, and "XJH-900 heart disease computer monitoring network" headed by Zhang Jinjing [1728 6930 2529]a, a young physician at No 1 People's Hospital, are both landmark achievements. Professor Ma Chunrong will lecture in the Soviet Union on his project at the invitation of the Academy of Science of Ukraine. With the successful development of the "XJH-900 heart computer monitoring network," China can expect to set up its first heart disease computer monitoring system outside the hospital at the end of this year. Worldwide only the U.S. and France have such a system.

This year Zhenhua Foundation has again decided to fund 10 projects after reviewing the applications submitted last year. If you compare the last 2 years, whether in terms of the number of projects funded or the amount of grants, the trend is clearly up. The projects selected this year have three other outstanding features. First-,there is a boldness to support the projects of young scientific researchers. Six of the winners of the "First Youth S&T Prize" submitted applications last year. Among them were "Duck Disease and the Development of a Vaccine for Hepatitis in Ducks," by Gao Fu, [7559 4395], a lecturer at Beijing Agricultural University, "ternary rare-earth long-lasting metamorphic substance and Metamorphic technology," by Professor Chen Yurong [7115 3768 0516], an associate professor at Harbin Industrial University, and "Image Analysis of the Cytochondriome internal enzyme in KM-mouse subgroup," by Shi Shundi [0670 7311 1229], an associate researcher at the Experimental Animal Institute of the Academy of Medicine. The average age of these three researchers is 33, and their projects account for one third of the funds allocated. Second, in response to the exhortations of the CPC Central Committee and State Council, the foundation has shown a preference for agricultural and energy projects. Last year no project in those categories received any money. This year five received funding through fair competition in accordance with the principle of selective support. Third, based on the opinions of the rank-and-file S&T personnel, the foundation this year has offered funding support to unique and high-standard basic research projects even as it gives the most weight to applied research.

Trial Reform of Research Organizations in Large Enterprises

90FE0290G Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 90 pp 17-19

[Article by Wang Zhicheng [3769 1807 2052] and Yu Lumiao [0060 7627 8693] of the Jilu Petrochemical Company Research Academy: "Attempts To Reform Research Academies and Institutes in Large Enterprises"]

[Text] **Abstract**

This article introduces the overall ideology, basic content of reform, results achieved, and problems that exist in reform of the S&T system in the Jilu Petrochemical Company Research Academy.

Reform of the economic system has brought enormous vitality to China's economy and significantly affected other realms, which requires all other realms to make corresponding reforms. The 1985 "CPC Central Committee Decision Concerning Reform of the S&T System" immediately clarified the direction of reform for S&T departments. Guided by the spirit of the "Decision," our academy accelerated the pace of reform. After several years of exploration and practice and continual intensification and perfection, we basically formed a scientific research system model that conforms to the characteristics of our academy. It has increased our self-development capacity, enormously promoted development of scientific research and other work, and contributed significantly to technological progress in the company. We made a total of 68 S&T achievements over the past 3 years, equal to 37 percent of all achievements in the past 16 years since the academy was established. The achievements used in industrial production in the Jilu Company can increase our income by more than 7 million yuan each year. We have published over 150 articles in various scholarly publications and academic conferences, and 12 articles have been used in international academic conferences and well-known foreign scholarly publications. We have applied for 12 patents, received seven patent numbers, and had three approved. Each year we assume responsibility for several key topics from the China Petrochemical Corporation and State Science and Technology Commission. In 1988, the Shandong Provincial Science and Technology Commission selected us as a "trial unit for plant-run scientific research and development organs in Shandong Province."

I. The Overall Train of Thought in Reform

Reform in our academy began in the early 1980's. In 1980 our academy began considering and implemented on a trial basis an "economic responsibility system" and in 1982 we formulated and comprehensively put into effect implementation methods for the "three types of contractual responsibility [for labor, output, and costs] and the three fixed things [fixed quotas for production, purchasing, and marketing]." In 1985, after announcement of the CPC Central Committee decision concerning reform of the S&T system, the company signed its first scientific research project compensated contract and economic responsibility system with our academy and worked in the areas of opening up technology markets, reinforcing extension of achievements, and horizontal technological integration. The essence of reform in the S&T system is changing and readjusting relations of production in the S&T realm and their related superstructure. According to the decision of the CPC Central Committee concerning reform of the S&T system, for a research and development organ under the jurisdiction of a petrochemical enterprise, while considering the reform model for our academy, our basic train of thought was: 1) Reform must be guided by the strategic principle that "economic construction must rely on S&T, S&T must be oriented toward economic construction" and they were carried out along this direction. 2) It first of all had to be based on technological progress in Jilu Petrochemical Company and on the petrochemical industry, and it should make appropriate efforts oriented toward society and toward other industries to develop technological, development, and applied research, and promote S&T progress in its own enterprises, its own industry, and its own region. 3) Gradually reinforce self-development capabilities, destroy the "big common pot," achieve a transition and change, and eventually build it into a new type of scientific research organ with full vitality and substantial reserve strengths. 4) The goal of reform is to make more achievements, produce talented personnel more quickly, and make greater contributions to the prosperity of the nation.

II. The Framework of System Reform

Reform in our academy was permeated from beginning to end by an "economic responsibility system" and "contractual responsibility." For this reason, continual intensification and perfection of the scientific research contractual responsibility administrative system was a primary aspect of reform.

A. The Scientific Research Contractual Responsibility Management System

Since reform, our academy has revised and promulgated several "Scientific Research Contractual Responsibility System Implementation Methods" and "Scientific Research Contractual Responsibility System Reward and Punishment Methods," and we have now formed a complete set of scientific research contractual responsibility systems which conform to realities in our academy and are rather perfect. Over the past few years, our academy has focused closely on intensifying and perfecting the contractual responsibility system, which is a central link, by implementing various types of contractual responsibility administration systems focused on making an effort in depth and breadth, and thereby forming a scientific research contractual responsibility

administration system composed of nine different contractual responsibility system patterns (including scientific research topics, scientific research and production, technical maintenance, analysis and testing, information and data, design and development, and labor service contractual responsibility administration system as well as an organizational goal contractual responsibility system and single item contractual responsibility system) to move contractual responsibility into all areas in our academy. During the process of implementing the administrative responsibility system, we reinforced inspection and examination to ensure that it was implemented correctly. At the end of each year we drafted a contractual responsibility program for the following year and appraised it at the beginning of the year. It went into effect after both the academy and office signed it and was implemented. The implementation situation for the academy as a whole was summarized and examined each quarter and quarterly bonuses were issued after examination. A comprehensive summarization was made at the end of the year. After the inspection, yearly award levels were determined based on the contract completion situation for the entire year and they were honored.

B. Academy Director Responsibility System

Implementation of an academy director responsibility system was an important aspect of reform in the S&T system. To ensure implementation of the responsibility system, with support from the company, our academy formally implemented an academy director responsibility system in 1985 and formulated three detailed work regulations for the academy director, CPC committee, and employee congress. Over the past 5 years, our academy has formed a powerful integrated body with the academy director as its center that closely integrates party political work and workers, and it has laid a solid foundation for fostering the effects of the integrated body and intensifying reform. To increase the degree of science and democracy in decisionmaking by the academy director, after implementation of the academy director responsibility system, our academy immediately readjusted and enriched the original technology commission. We invited senior engineers from the company and production plants to serve as "visiting committee members." We established an academy service committee composed of the academy's party political work group and employee representatives. We also established a scientific research management consulting committee. Our academy also invited three experts and professors from outside the company to serve as research academy advisers and do consulting on a fixed schedule. Practice has proven these expert committees and expert advisers played an important role in helping the academy director in the area of decisionmaking.

C. Funding System Reform

Reform of the scientific research allocation system and management methods are an important part of reform in the S&T system in China. To adapt to reform of the allocation system, our academy made substantial changes in the funding system. First, we worked with the company to reform the company's methods of making allocations to the academy. We changed from the large unified "scientific research operation fund" allocations of the past to dividing them up into separate parts for scientific research expenditures, administrative expenditures, and award funds. Our academy signed a scientific research project compensated contractual responsibility contract with the company in which the academy guaranteed the completion of scientific research tasks and the company guaranteed allocations for scientific research and various expenses. Our academy no longer received unified awards provided by the company.

Second, we implemented diversification of funding sources, promoted a technology contract system in many areas, reinforced horizontal integration, opened up technology markets, and accepted topics assigned by outside parties. This solved society's needs for technology and increased our academy's income. It also reinforced technical cooperation in all areas and optimized deployment of the social forces of production. We began reinforcing topic accounting in 1986, established a topic expenditure accounting system, established scientific research topic cost cards, reinforced accounting and management of scientific research expenditures, and conserved outlays. In 1986, the first year that the topic accounting system was implemented, we saved about 118,000 yuan on scientific research materials costs alone. Actual outlays for most topics were within +/- 20 percent of budgets made at the beginning of the year, while actual outlays were less than the budgets at the beginning of the year in 80 percent of the topics. Reform of the funding system opened a channel for reform of the entire scientific research system and created the conditions for further intensive reform.

D. Personnel System Reform Was Another Important Aspect of Reform in the S&T System

The central goals of reform in the personnel system of scientific research units were, first, to motivate initiative and promote development of scientific research and S&T progress. Second, it should benefit personnel development by producing talented people quickly while making more achievements. For this reason, focused on these two centers, our academy concentrated mainly on the following items of work during reform of the personnel system: 1) We brought in competitive mechanisms and implemented an appointment system for all cadres, formulated goals for the period of appointment and a responsibility system, clarified responsibility, held inspections at fixed schedules, and destroyed the lifetime appointment system. 2) We implemented a study group personnel optimized combination. The optimized combination raised the enthusiasm of all employees and S&T personnel and increased the quantity, quality, and incomes of research topics. Moreover, many young study group leaders and special topic group leaders appeared, which provided the academy with successors for key scientific research personnel. 3) We implemented a "two

flexibility" policy to promote rational personnel circulation. In 1988, our academy formulated "Some Research Academy Stipulations Concerning More Flexibility for Laboratories and Flexibility for S&T Personnel" that removed fetters from large numbers of S&T personnel and increased their initiative, and it was welcomed inside and outside the academy. 4) Focus on personnel development, accelerate personnel training. Our academy formulated a long-term plan for personnel training and formulated different training goals and plans for personnel at different levels. For example, our academy formulated "Provisional Management Methods for Training Key Young S&T Personnel" and "Appraisal and Award Methods for the Results of Directional Training for Key S&T Personnel" and implemented a key personnel directional training arrangement for S&T personnel which included a tutoring system. We trained a total of 24 key young personnel in 3 years and 14 people have completed their training plans. Ten people have attained the capacity for independently taking on topics, including eight who became special topic group leaders and seven recommended as superior provincial young workers. Some 80 percent of the personnel trained have received superior thesis awards or scientific research achievement awards.

E. Distribution System Reform

The distribution question is a sensitive issue that is directly related to the personal economic interests of each person. The success or failure of reform in the distribution system directly affects the success or failure of reform, so each step taken has to be taken extremely carefully. Through continual exploration and practice, our academy has now basically formed a relatively rational distribution system. First is bonus distribution which corresponds to each other type of responsibility system by linking bonuses to achievements, benefits, and work quality. Second, quantitative evaluations are made of scientific research topics and a topic quantitative evaluation system was established to quantify scientific research labor and scientific research achievements. Third, we established an academy director fund and office director fund to provide special commendations to academy directors or office directors who made prominent contributions. Fourth, we established nine types of single awards to provide single-item awards to those who made special contributions in certain areas. Reform of the distribution system has initially destroyed egalitarianism, encouraged advances, stabilized staffs, and stimulated the sense of achievement, enthusiasm for labor, and initiative of large numbers of S&T personnel.

III. Accomplishments in Reform, Problems That Exist

Overall, reform in our academy is basically successful and we have made important accomplishments. Many gratifying changes have occurred in our academy since reform, mainly in three areas: 1) We have made changes. Several reforms converted our academy from a purely scientific research type in the past to a scientific research management type and from a closed type to an open type. Our academy has established integration and cooperation relationships with several 10 industrial plants, institutions of higher education, and scientific research units since 1985. These have reinforced our strengths in scientific research to attack key problems, raised S&T levels in our academy, provided technology for society, and increased academy income. 2) We have raised management levels. Scientific research management work is becoming increasingly systematic, procedural, and scientific. The big common pot has been destroyed and everyone has clear duties and tasks. We have reversed the phenomenon of an imbalance between busy and idle, and gradually developed toward higher efficiency and quickness, conservation, and effectiveness. 3) We have motivated initiative and led to the appearance of "five mores" phenomena: more topics, more "rice for the bowl," more concern for extending achievements, more people concerned with the front line of scientific research, and more people dedicated to scientific research. These phenomena show that the role of reform measures is positive and that reform has entered deep into people's hearts. At the same time, however, several problems have existed in reform over the past few years, including: 1) Some S&T personnel are unwilling to take on state projects to attack key problems and are unwilling to work on big projects and difficult projects. They only want to do projects which involve "short schedules, smooth progress, and quick results" because these have short schedules, produce results quickly, and provide more material benefits. If this persists for long it inevitably will affect the quality and levels of S&T personnel and may cause mistakes in the direction of scientific research. 2) Some S&T personnel and auxiliary personnel have a tendency to "think money is everything" and lack a spirit of dedication to scientific research and the professional ethics of scientific research. 3) Research institutes which serve as enterprises should rely on their own ability to generate income to provide all their development capital, welfare funds, and award capital but they cannot delay tasks which promote development of production in enterprises and technological progress, so the pressures are extremely great. Scattered S&T forces, insufficient scientific research funds, and the continued increase in rising cost factors make it impossible for them to renew instruments and equipment. These problems will inevitably affect the development of scientific research work if they are not resolved.

Further Reform of Research Institutes

90FE0290F Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 90 pp 13-16

[Article by Xu Guohua [1776 0948 5478] of the Shanghai Branch, Chinese Academy of Sciences: "Ideas on Some Questions in Intensive Reform in Research Institutes"]

[Text] **Abstract**

This article integrates with practice in reform in recent years in the various research institutes in the Shanghai Branch of the CAS to discuss effective integration of technology and the economy, rational deployments of R&D, plan management and market regulation, stabilizing scientific research staffs, training superior quality personnel, and other questions, and offers some opinions.

Reform in CAS research institutes has been in progress for nearly 10 years. There are now major changes in the appearance of each institute and they have made outstanding achievements. However, there are many problems that deserve consideration. In integrating with practice in reform in research institutes in the Shanghai Branch, I deeply feel that the following problems must be solved in further intensive reform.

I. On the Question of Reinforcing Effective Integration of Technology and the Economy

Promoting integration of S&T and the economy is the chief melody of reform in the S&T system. Over the past several years, all institutes in the Shanghai Branch have done broad-ranging exploration in both guiding ideology and work practice, with gratifying progress. These are manifested mainly in: 1) Positively and actively extending scientific research achievements rapidly into production that were shelved in the past and made recently. According to statistics, the extension and utilization rate for scientific research achievements prior to 1983 was just 30 to 40 percent, but it surpassed 80 percent in 1988. The numbers of technology transfer and technical service contracts in each institute have increased every year, from 376 in 1984 to 641 in 1985 and 905 in 1988. 2) The research institutes have transferred single technological achievements to establish several jointly-managed plants with local enterprises and township and town enterprises for jointly producing and managing new product development. By the end of 1988, institutes in Shanghai had established over 70 jointly-run plants of various types in the suburbs of Shanghai and in Jiangsu, Zhejiang, and other areas. 3) The research institutes have served as the main party in establishing several S&T vanguard enterprises and technological development companies that integrate scientific research, production, and management into one body. Institutes in the Shanghai Branch of the CAS now have three Chinese-foreign joint investment companies. Stipulations after improvement and rectification allowed retention of 29 institute-run companies.

It should be pointed out, however, that the levels of S&T and economic integration described above are not high enough, a balance has not been achieved between the incomes research institutes earn from technology transfers and their inputs, and the scale of the management bodies is not large enough. In the overall view, they are far from having established benevolent cycles between S&T and the economy. Many enterprises, especially large and medium-sized enterprises, are not enthusiastic about accepting transfers of scientific research achievements. To readjust their product mixes, enterprises need for research institutes to provide mature new products with excellent market prospects. Research institutes face several problems during the process of developing achievements into industries and growing to a definite scale, including capital, manpower, sites, and so on. In the final analysis, the main causes are in the following areas. The first is system separation. In China, S&T and the economy are two independent and parallel systems. Although technological progress should be the vanguard of economic development, in the existing system enterprises lack power and are unwilling to invest their capital in specialized research organs. Research institutes form their own system and do not have specific real products as their goal. To a certain extent, scientific research and production are detached. Second, there is a blank zone between scientific research and production. Under normal conditions, scientific research achievements by research institutes cannot become enterprise products. There must be an intermediate process involving several instances of development, trial manufacture, and improvement which require much larger investments than research expenditures. At present, it is very hard for enterprises to obtain the achievements they need because these links are incomplete. Third, the necessary external conditions for transforming scientific research achievements are absent. Some achievements have already been turned into products but they have been shelved for long periods because insufficient forces were invested into opening markets and expanding the range of applications. Some achievements have high technical levels but their cost is also high, so enterprises are unable to accept them. Still other single technological achievements have not become forces of production because they lack the related matching technologies. The conversion of S&T achievements involves systems engineering, and several specialized organs whose goal is not to profit should be established to do work to transform achievements.

China is now in a period of economic difficulty. We have capital shortages and weak markets. In this type of situation, it is very hard for the government and enterprises to increase their inputs into S&T substantially. Still, now is an excellent opportunity to take advantage of the role of S&T in promoting the economy. Shanghai is a big industrial city. It now faces a variety of tasks in technical transformation and readjusting the industrial structure and product mixes, so there is much that scientific research units can accomplish. There are many routes and broad prospects for integrating S&T and the economy. For research institutes, good work on this necessary condition for integration first requires maintaining and fostering the technological advantages and characteristics of each institute. If research institutes have superb technologies and strong points and their research projects and achievements are adapted to the needs of developing production, enterprises will be enthusiastic. Attacks on key problems were necessary for many technological problems in a color film production

line and a shift to domestic production of raw materials among the battle for 14 key projects in Shanghai Municipality. In city-wide bidding, Shanghai Organic Chemistry Institute won the bid in one fell swoop. This institute had a solid disciplinary foundation and rich practical experience in this area. It worked together for many years with several units in the photographic sensitivity industry and gained the trust of enterprises and government administrative departments, so both sides were willing to engage in long-term cooperation. Second, they encouraged S&T personnel to go into the real world and take the initiative in discovering and solving technical problems. Technical strengths in normal enterprises are inadequate, so they cannot solve many technical problems. S&T personnel from research institutes must go into the enterprises themselves to be able to discover and find ways to solve problems and be supported and welcomed by enterprises. Recently, the Shanghai Municipal Science and Technology Commission set forth the question "in economic difficulties, what can science and technology do?" They organized some scientific research units to go to some export earning enterprises in a selective and focused manner to develop technical consulting activities. On the basis of several initial accomplishments they made, they also agreed through joint consultations with light industry departments concerning several projects to attack key problems and raised some capital for joint attacks on key problems by research institutes and enterprises to improve product quality and export grades. The development momentum of this sort of cooperative arrangement is quite good now. This was another good way to integrate S&T with the economy after the city-wide battle for projects to attack key technical problems.

II. On the Question of Rational R&D Deployments

Since implementation of reform in research institutes, the changes in their internal structure are manifested first of all in stronger development work. The various institutes in the Shanghai Branch readjusted their topics for several years in succession after 1983. They gradually stopped topics of little importance that involved low-level repetition and unclear applications prospects and shifted toward work with short-term results that can earn funding support. This brought major changes to the proportions of topic categories. According to statistics from 14 institutes, development research accounted for 16.3 percent of all topics in 1984, but rose to 22 percent (not including company development projects) in 1988. At the same time, all the institutes also reinforced redevelopment of their existing achievements such as systematic research on technical conditions, determining technical parameters, doing small-batch trial production of original prototypes and samples, and so on, and they focused on placing stage achievements in several larger projects into use as quickly as possible. Research personnel in all the institutes were extremely active in carrying out all sorts of technical consulting and technical service activities.

However, during the process of working on development tasks, the tendency to neglect intensive systematic research work led to a decline in scientific research levels, inadequate reserve strengths in development work, and gradual weakening of some original advantages and characteristics. These were manifested mainly in: 1) Weakening of basic research. There was practically no reduction in the proportion of basic research (including applied basic) topics among the three categories of work, as it was maintained at about 30 percent. Actually, however, there were more problems, mainly in smaller topics, scattered investments, failure to renew equipment, withering of research work, and difficulties in continuing with quite a bit of special work which increased the lag behind advanced international levels in some realms. 2) Inadequate development reserve strengths. Most development projects in recent years have used accumulations made over several years. There has been a gradual reduction in the former achievements of each institute and they have worked hard to extend and apply all those that can be utilized, so subsequent ones cannot keep up. Because of capital and manpower restrictions, research institutes are unable to make leading arrangements for many research projects based on market demand. 3) A reduction in major achievements. After reform, there was a serious tendency toward scattered topics, shorter research schedules, and limited investment strengths, so it was hard to make major achievements. For example, some research institutes made several achievements but few were high-level achievements. Some institutes received many awards but levels were low and lacked noticeability.

This situation has worried scientific research personnel for quite some time now. They are again calling for this situation to change. However, because of restrictions by their external environment and internal conditions, this situation has not changed significantly so far and shows a tendency toward continued development. It has now reached the time when it must be dealt with conscientiously. First, we must provide research institutes with self-regulation measures. Macro management departments should be concerned both with macro deployments (such as organizing major projects) and with providing research institutes with specific regulation measures. After reform of the allocation system, only minute funds were retained by research institutes and they were unable to reinforce many obviously weak links. The state should understand and help research institutes overcome difficulties and problems encountered in reform. Second, we should be concerned with the guiding role of policies. Several existing policies are not conducive to stability in basic research and work involving rather long schedules but instead benefit projects with "short schedules, smooth progress, and quick results." This sort of short-term behavior has substantial effects on basic research work. Third, we should raise decisionmaking and management levels in the research institutes themselves. Faced with a similar external environment and roughly similar international conditions, some institutes are gradually withering and

are at their wits' end. Other institutes pool the wisdom and efforts of everyone and make rational deployments, and their research and development are both growing. This shows the importance of the decisionmaking capabilities and management levels in the research institutes themselves.

III. On the Question of Plan Management and Market Regulation

Several changes have occurred in the management systems of research institutes in recent years as a result of the effects of their external environment. On the one hand, there are fewer vertical tasks and more horizontal tasks, and local areas and enterprises often propose unanticipated research topics. On the other hand, research institutes often readjust their own research targets in response to changing production needs and markets. For this reason, completely planned management is not possible and they should foster the role of market regulation based on the principle of integrating S&T with the economy. In the current situation, however, planned management is still very important given realities in the institutes. First, in the sources of research topics in the institutes, vertical tasks account for a very large proportion, including attacks on key problems in the "863" and Seventh 5-Year Plans, CAS major projects, and other directive tasks, which account for about 70 to 80 percent. Two-thirds of scientific research expenditures are allocated by higher authorities. This is an important channel that is not easily ignored. Second, tasks arranged according to plans embody the needs of the state and society for S&T and represent the advantages of these research institutes. Most vertical tasks were obtained through intense competition and technology contracts signed with administrative departments. To protect the reputations of research institutes and the CAS, all these tasks should be completed on time to embody the seriousness of plans. Third, based on the need for improvement and rectification, we should reinforce management of technology markets. Development work cannot stop again in a piecemeal approach nor can it follow markets without limitations by doing only that which earns money. Instead, it should gradually establish stable base areas and "fist" products according to the technical characteristics of an institute and contribute to the development of China's high technology industry.

Of course, reinforcing planned management does not mean a return to the model of the past. The state is now implementing a planned commodity economy and research institutes are also carrying out commodity production directly or indirectly to varying degrees. As a result, this part of their work cannot avoid restriction by market laws and should shift toward the new mechanism of market guidance. Most research institutes now have scientific research work focused on planned management and product development restricted by markets. Implementation of two types of management systems and operational mechanisms for these two different kinds of work is correct and conforms to actual conditions, and it is conducive to healthy development of these two types of work. After several decades of practice, research institutes surely understand the laws of scientific research work and they have established a relatively complete set of planned management systems and methods as well as accumulated rich experience. The question today is how to adapt to the new situation and further perfect it. Still, the development system with guidance by markets is unfamiliar. This system is very incomplete and awaits reinforcement. We should establish a sensitive market information system in the development system to facilitate readjustment in our own work according to changes in market demand. We also should have specialized marketing management organs to establish close relationships with users, not sit locked in the research institutes waiting for users to come to the door. Development work especially needs capable and efficient administrative and management personnel. These problems require a period of exploration and practice.

The various institutes in the Shanghai Branch have now adopted two models in the area of development systems. One is the management-style model in which research institutes establish a functional organization for administrative development that is parallel to planning departments to take responsibility for organizing and implementing achievement development for the entire institute with attributive management of all types of technical services and technology transfer activities with outside parties and whose income and allocations are under unified accounting by the institutes' financial administrations. The Shanghai Metallurgical Institute and Silicate Institute are basically this type of model. Another type is the administrative-type model, which uses a company arrangement to implement independent administration, independent accounting, and responsibility for its own profits and losses. The research institutes implement supervision and guidance over the companies through a board of directors and company managers develop various types of administrative activities according to market conditions and their own strengths. The capital is input at one time by the institutes and profits are shared according to an agreed-upon proportion. Two companies in the Shanghai Optics and Fine Mechanics Institute and Organic Chemistry Institute are representative to a certain extent but they still need perfecting. All types of administrative organs should gradually implement fully independent decisionmaking administration and accounting based on the need for conversion to enterprises.

IV. On the Question of Stabilizing Scientific Research Staffs and Training Superior Personnel

Changes have occurred in people's concepts of value since reform and opening up. The incomes of some people who have moved toward development are rather high, which has caused some wavering in the morale of people involved in basic research and attacks on key problems. They are not content to do only accumulative and reserve-type work and wish to do some development at the same time by implementing a "one person, two

systems" or "one group, one product" (in which a study group embraces a single product). Doing things this way scatters forces and affects work in both areas. Moreover, as the number of personnel leaving China has grown, personnel circulation has become more serious. Many key scientific research workers do not return on schedule and research staffs are unstable, which has already created serious crises for research institutes. Now, even the "863" and Seventh 5-Year Plan projects to attack key problems have been affected in some research institutes because people responsible for topics and key researchers have left. In some institutes, nearly all the graduate students trained over the years have left. Some scientific research personnel are unwilling to accept additional tasks because they fear it will affect their leaving China. This sort of situation makes some institutes feel that their ambition for taking on key projects or doing rather long-term work exceeds their abilities and they are deeply worried about the future.

The problems of aging and a lack of successors are extremely acute in scientific research staffs. To deal with this situation and stabilize scientific research staffs, training talented young people is an urgent task in research institutes. First, they should conscientiously study and formulate policies to motivate the initiative of all types of personnel and allow all personnel involved in different types of work to play a role. Personnel engaged in basic work and attacks on key problems should be given rational bonuses and subsidies to ensure that their incomes and those of development personnel do not drift too far apart. We should correctly evaluate the work of personnel involved in development and be concerned with their professional growth and job title determinations. Create an atmosphere in research institutes to enable all scientific research personnel to find jobs that allow them to play their role according to their own characteristics. Second, we should adopt all effective measures to retain and attract talented people, improve the working and living conditions of scientific research personnel, solve their housing problems, and so on. Third, make major efforts to train young people. Promote capable and accomplished young people to responsibility for study groups or leadership of research offices, select young people with potential and prospects to be academic leaders for focused training, and so on. The Shanghai Technical Physics Institute established a special young people's research office composed of master's and doctoral students. This is a very good way to accelerate the growth of young people and discover and train talented personnel. Fourth, reinforce ideological education. In work to stabilize and train scientific research staffs, we should be concerned with and foster the role of ideological and political work, see the importance of educating scientific research personnel as in the national interest, and foster the spirit of dedication, unity, struggle, and heart and soul dedication to the cause of contributing to the strengthening of China's economy and raise scientific levels.

Operation of Research Institutes, Management System Reform

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[Text] **Abstract**

This article is part of the main topical report of the "Research Institute Operational Mechanism Research" Study Group's "Discussion of the 'One Academy, Two Systems' Development Strategy and Research Institute Development Models and Operational Mechanisms." The article mainly discusses the basic laws of research institute operation, reform of the research institute management system, development models for each type of research institute, improving the operational mechanisms of research institutes, and other issues.

As reform of China's S&T system has continued to intensify and scientific research academies and institutes have made new developments in all aspects of their work, they are also facing rigorous tests and challenges. To further intensify reform and gradually place research institutes on the development track of benign cycles, a discussion of the basic laws of research institute operation and management system reform is necessary.

I. Basic Laws of Research Institute Operation

Research institute operation should observe the laws of natural science development and the laws of the socialist commodity economy. Observing the laws of natural science development means, based on the reliance of natural science development on production and its characteristics of being relatively independent of production, making production practice the fountainhead of natural science research and the standard for examining natural science research achievements, making full use of the measures and conditions provided by production to do scientific experiments that lead production, applying logical inference methods to do theoretical research, and continually discovering, accumulating, and intensifying by revealing natural laws to push S&T without limits toward the leading edge of development and thus open up new routes for production, arouse new production demands, and promote the development of production. Observing the laws of the socialist commodity economy mainly refers to transforming S&T achievements into

forces of production, observing the laws of market operation during the process of converting technical achievements into commodities, and using market demand as a motive force to set tasks and requirements for scientific research and technological development to promote technical progress and increase economic benefits for production.

To illustrate the role of these laws in research institutes, we must analyze the transfer of achievements from scientific research and production activities and information transmission operations. This is outlined in Figure 1. Generally speaking, the entire process of scientific research and production activities can be divided into four interlinked stages. They are scientific research (including basic research and applied research), technological development (including R&D and intermediate testing), product development and production (including experiments to enlarge the scale of production and batch quantity production), and commodity business and marketing (commodity sales and after-sale services).

Scientific research and production activities are a system whose four stages form two relatively independent but related subsystems. One is the natural science research activity system. Its goal is to understand nature and transform nature. Its motive force is the need to promote development of S&T itself. The inputs of this subsystem are information from the natural world and academic information (knowledge). Its outputs are academic treatises (new knowledge) or patented achievements. The other subsystem is the technical economics activities subsystem. Its goal is satisfying social and economic needs, its guide is the market, and it carries out technological development, product production, and market transaction activities. The inputs of this subsystem are mainly market information and applied research achievements. Its outputs are commodities entering the market (including technical commodities which enter technical markets). These two subsystems are integrated through applied research. Applied research derives information from development and research and provides new ideas and methods for R&D. It also derives theoretical guidance from basic research achievements and provides research topics for basic research. It should be pointed out that the latter subsystem also contains several different and interlinked sub-subsystems (stages). The two sub-subsystems in the intermediate stage between scientific research and production (development research and intermediate testing) are integral parts of scientific research and production that have their own transitional characteristics. They both use the market as a guide but usually do not supply commodities to common commodity markets. They can, however, carry out technology trade in technology markets, including technology transfers.

The preceding analysis shows that the operational laws of the two subsystems in scientific research and production activities are different. They must organize different implementation organs, implement different management systems, and adopt different management methods according to the characteristics of each type before each can perform its functions. The two subsystems are interrelated and coexist, however, and they are both part of a larger system. Each of these two subsystems must operate according to its own laws before they can be mutually promoting and place the entire system into an optimum state.

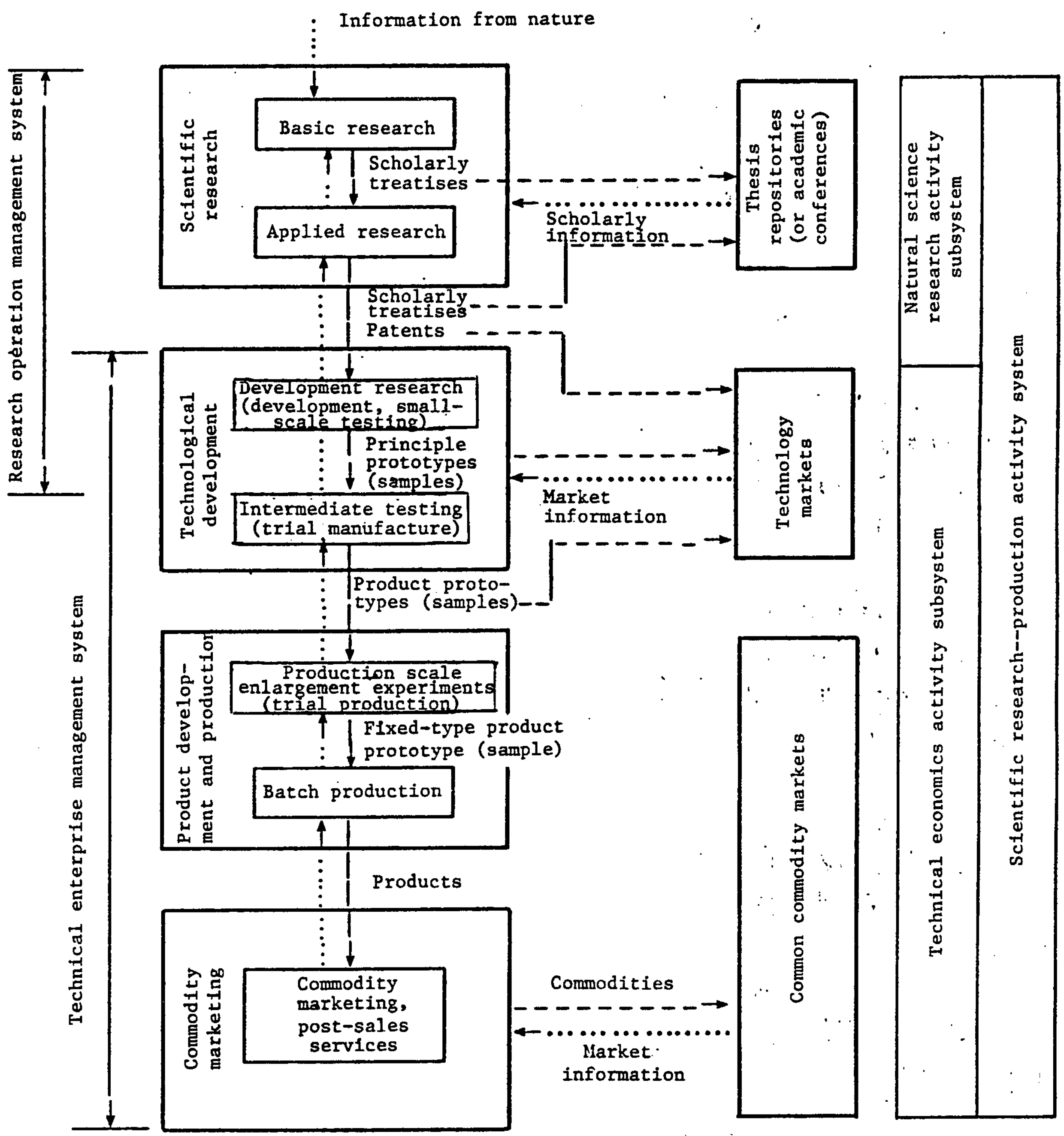

Figure 1. Diagram of the Scientific Research—Production System Achievements and Information Operational Mechanisms and Management System

II. Research Management System Reform

Before reform, the basic tasks of research institutes were topics assigned in plans or freely selected. All of their funds were allocated by higher authorities, all of their personnel came from unified allocation in plans, and their achievements ended with registration, examination, and acceptance. They were a type of enterprise unit planned management system. With reform of the economic system and S&T system, changes in the allocation system and the appearance of technology markets promote conversion of technological achievements into commodities. Moreover, with the opening up of laboratories, establishment of the natural science fund system, and expansion of the scope of work in many research institutes, the old research operation management system is no longer adapted, so we must establish a new operational management system and the necessary technical enterprise management system, and we must coordinate the relationship between these two systems.

However, in the situation of China's planned commodity economy, development of technology market mechanisms is not yet perfected, S&T has not been integrated well with the economy, and socioeconomic needs are not directly reflected in markets, so we must continue to use state plans and adopt contract arrangements to assign tasks. As a result, a substantial number of applied research and technological development projects in many research institutes still come from state plans. This must be considered when analyzing operational mechanisms and management systems of research institutes.

A. Establish a New Research Operation Management System

Scientific research, whose motive force is the development requirements of S&T operations themselves including basic research, applied basic research, and technical basic research, requires the adoption of a research operation management system. Important, key, and basic S&T questions proposed during social and economic development are the primary tasks and research content of applied research. In China's current economic system, this applied research still requires adoption of research operation management systems, but all of them should be different from the new research operation management systems of the past.

1. New basic research management system. The new basic research management system should adhere to the principle of opening up, circulation, and integration. Its characteristics are: 1) In organizational structure, the main forms are establishment of open laboratories (including open field experiment stations) and certain specialized research centers. Attention also should be given to the new basic research system that is oriented toward fund topics. 2) Implement the method of open application and competitive selection for allocating topics. Open laboratory research topics can accept open applications from China and foreign countries to facilitate absorption of superior S&T personnel who come to the laboratories to work. Fund topics should submit applications to the funding committee. All these things embody competitive mechanisms and promote continual renewal of topics. 3) In personnel utilization and training, open laboratories should implement a few fixed establishments and many circulating visiting research personnel to invigorate academic ideas and help talented young people grow. 4) In research expenditures, implement a method focused on application to science funds to embody planned guidance and freedom in topic selection in basic research. However, science funds should have sufficient strengths to ensure that they attain high goals at world levels.

2. New applied research management system. Because the main task of applied research is to solve important key S&T problems in social and economic development, we should try to make state projects to attack key S&T problems during the Seventh and Eighth 5-Year Plans, state high technology development plan projects, local projects to attack key S&T problems, and important departmental projects the primary goals of applied research in China's key research institutes, and they are an important source of research funds. The new applied research management system should adapt to the state's management system for major scientific research projects, as embodied in the following points: 1) Because tasks are planned and competitive, we must create conditions advantageous to competing for tasks such as advanced instruments and equipment, leading scholarly accumulation and technical reserves, and open channels for task competition. 2) Because of the seriousness of task completion, we should adopt a research contract system and implement independent accounting methods for study group expenditures. There should be a strict system of rewards and punishments for the quality of task completion to ensure a high degree of prestige. 3) Because tasks to attack key problems require that achievements be capable of being converted into forces of production, we must organize integrated attacks on key problems from many disciplines, many specializations, and many units. In particular, we should require that technological development and product development be matched up, and the applied research management system should facilitate this type of integration.

B. A Transitional Management System for Technological Development

Technological development is integration of scientific research and production, so we should implement a transitional management system. This is determined by the characteristics of technological development work. Because technological development (especially development research) is exploratory and risky and cannot ensure recovery of invested capital, it is similar to scientific research work. However, its achievements have indirect or direct economic benefits. Definite economic incomes are obtained through the transfer of technological achievements, especially through sales of the products in intermediate testing. These are similar to the characteristics of product development work. For

this reason, the technological development management system basically should adopt the methods of scientific research management in project management (starting and establishing projects, examining and accepting achievements), while technological enterprise management methods can be adopted in economic management (cost accounting, achievement transfer, intermediate testing product sales). Overall, however, when the technological enterprise of a research institute has not yet attained a certain scale and economically cannot support its own technological development, the technological development management system can continue to be under the jurisdiction of the research operation management system for a rather long time period.

C. Establish a Technological Enterprise Management System

From product development to product production and commodity marketing, the role of market mechanisms is felt in a socialist commodity economy, so it should be managed as a technological enterprise management system. Like regular industrial enterprises, technological enterprises established by research institutes have their own special characteristics, so their management system also has its own characteristics: 1) The degree of technological intensity is high and the technological content of high technology enterprise products is even higher. 2) The proportion of technical personnel in the enterprises is high. Technical personnel in high technology enterprises generally account for 40 to 60 percent of total personnel in the enterprise. 3) Product renewal and replacement occurs quickly and large investments are made in product development. For high technology enterprises, these investments should be 5 to 15 percent of the sales volume. For this reason, from the beginning establishment of technological enterprises should adopt modernized enterprise management systems and management methods, and special attention should be given to establishing a strict product quality control system and product sales and service system.

III. Development Models for Each Type of Research Institute

Based on the scope of participation of research institutes in scientific research and production and the proportion of allocation patterns, we divided research institutes into four categories: basic type, social public welfare type, development type, and comprehensive type. Determination of the development model for a particular research institute should consider the following areas: direction of tasks (or development strategy goals) in the research institute, scope of work in the research institute and the type of research institute, operational mechanisms of the research institute, organizational structure of the research institute, and management system of the research institute.

The development model of a research institute should be dynamic and developing, and it should be continually readjusted according to conditions in the research institute itself and the objective environment. Neither can there be a single rigid framework for development models for research institutes of the same type. The development models for each type of research institute provided below are merely for purposes of analysis under ideal conditions.

A. The Development Model for a Comprehensive Type Research Institute

China's comprehensive research institutes usually are all involved in the entire process of the scientific research and production activity system, but applied research is still the main force at the present time. From the perspective of the number of S&T personnel inputs, applied research accounts for about 40 to 50 percent of the total number of S&T personnel in the scientific research and production activity system. Applied research accounts for about 60 percent of the total number of S&T personnel involved in basic research, applied research, and development research. Although there are substantial differences in the number of S&T personnel doing applied research that are involved in state projects to attack key problems, high technology development plans, and key departmental projects, they generally account for more than half in most cases. This structure describes the current situation and shows that it is adapted to the needs of social and economic development at the present time. Whether in terms of their contributions to national economic construction or competition for scientific research expenditures, key research institutes should concentrate their forces on state projects to attack key problems, high technology development plan projects, and key departmental projects for a substantial amount of time into the future. In the perspective of short-term development, it is most appropriate for comprehensive research institutes in general to maintain involvement of about 40 to 45 percent of their forces in applied research, 15 to 20 percent in basic research, and 20 to 25 percent in technological development and production and marketing. From the perspective of organizational structure and management systems, comprehensive research institutes in the past had three main parts, the so-called two small ends (basic research and development research) and large middle (applied research). Although each part had its own characteristics and differences in management methods, all were research operation management systems. Structural readjustments in recent years have reinforced development work. There is technological development as well as product development and production and marketing. This added another part to the structure of research institutes to make four parts. The addition of this part (product development and product production and marketing) cannot continue to use the original research operation management systems but should establish a technological enterprise management system. As for the part of technological development, this is a transitional system. On the basis of the development situation in the two systems within research institutes, it may be possible to shift to a technological enterprise management system, and it is possible that this type of technological development project may have a divided jurisdiction under two

systems. In summary, the development model for comprehensive research institutes eventually will form four parts and two systems, as shown in Table 1.

Table 1. Comprehensive-Type Research Institute Management System and Proportions of Each Type of Work

Basic research	Applied research	Technological development	Product development, production and marketing
15-20 percent	40-45 percent	20-25 percent	20-25 percent
Research operation management system		Technological enterprise management system	

B. The Development Model for a Development Type Research Institute

Development-type research institutes are usually involved in applied research, technological development (project development), product development, and product production and marketing, but the main aspect is technological (project) development, accounting for about 50 percent. To reinforce its development reserve strengths, applied research (including applied basic and technological basic research) accounts for a substantial portion in this type of research institute, about 25 to 30 percent. The forces in some development-type research institutes involved each year in state projects to attack key problems, high technology development plan projects, and key departmental projects also account for a very large proportion of research and development S&T personnel, usually more than 50 percent. Based on the conditions in a research institute itself, development-type research institutes can have two types of development models which attain the same goal via different routes. One is to begin with a focus on technological development and new product development systems using the market as a guide and shift from a scientific research operation management system to a technological enterprise management system to achieve better economic results for the research institute in development and administration and develop toward a scale economy. They also focus on reinforcing technological development reserve strengths and input their forces according to the direction of development research into longer-term applied research and technological basic research, as shown in Table 2.

Table 2. Development-Type Research Institute Management System and Proportions of Each Type of Work—I

Applied research	Technological (engineering) development	Product development	Product production and marketing
20-25 percent	40-45 percent	15-20 percent	10-15 percent
Technological enterprise management system			

The other route is to focus on research and development of high-level technology (projects) and science to involve the research institute's crack forces in high technology tracking and applied basic research, involve its main forces in developing engineering technology projects, and open up applications of high technology products in the market. At the same time, they cannot neglect management of the development of normal product development and technical services. Thus, in its management system, this model has two systems, the research operation management system adopted for applied research and the technological enterprise management system adopted for product development and product production and marketing. The technological (project) development situation comes under the jurisdiction of two systems, as shown in Table 3.

Table 3. Development-Type Research Institute Management System and Proportions of Each Type of Work—II

Applied research	Technological (engineering) development	Product development	Product production and marketing
25-30 percent	40-45 percent	10-15 percent	10-15 percent
Research operation management system	Technological enterprise management system		

C. The Development Model for a Social Public Benefit-Type Research Institute

A social public benefit research institute is another comprehensive-type research institute which includes basic research, applied research, development research, and extension services. The research achievements of this type of research institute mainly involve creation of social public benefit through extension services that have no or very little economic benefit, so they undoubtedly should adopt a research operation management system. However, some of their research achievements can be converted via technological development and product development into products that enter markets and create economic benefits. Although this part of development work accounts for a small proportion, it is extremely important that attention be given to the definite economic income these research institutes earn from their contributions to the national economy, so their management system of course is a technological enterprisemanagement system (see Table 4). It should be pointed out that obviously no technological enterprise management system exists in social public benefit research institutes that has absolutely no research achievements that can be used for product development.

Table 4. Social Public Benefit-Type Research Institute Management System and Proportions of Each Type of Work

Basic research	Applied research	Extension services	Development research	Product development administration
20-25 percent	60-65 percent	5 percent	5-10 percent	5-10 percent
Research operation management system			Technological enterprise management system	

D. The Development Model for Basic-Type Research Institutes

In principle, basic-type research institutes only do basic research, but they may also provide some consulting services for applied research which fall under the jurisdiction of research operation management systems. As a few basic-type research institutes are also concurrently involved in some technological development management work, it obviously is best if a technological enterprise management system is used for this part.

IV. Improving Operational Mechanisms in Research Institutes

To develop the development model of "one academy, two systems," research institutes must carry out extensive reform. The main task in reform is to improve operational mechanisms in research institutes to adapt them to China's economic system by moving from a single planned economy onto the track of the socialist commodity economy, conform to the laws of natural science development and laws of the socialist commodity economy, and thereby establish a perfect scientific research operation management system and technological enterprise management system.

Mechanism is a word taken from a foreign language. Its original meaning is the structure of a machine and the principles of its operation. Later, it came to be used in biology and medicine. "Mechanism" refers to the structure of an organic entity and its interrelationships. The word "mechanism" is now widely used in the social sciences and in daily life, mostly in reference to a type of self-regulating function that operates in each part of a system according to specific patterns and laws in the system. A mechanism is controlled by objective laws, but people can use these objective laws according to the factors of this system itself and its objective environment to create the conditions for fostering optimum functioning of the entire system. Based on this meaning of mechanism, improving the operational mechanisms of research institutes means that a research institute must be explored as a system whose individual parts (including research, development, production, administration, support by technological conditions, reserve services for life, and other subsystems) each operate according to laws of natural science development and the laws of the socialist commodity economy to perform their functions, and searching for optimum coordination and control methods and patterns in the system as a whole to foster optimum functional results of the research institute system as a whole.

The main inputs in a research institute are manpower, capital (including that converted into materials and equipment), and information. The main outputs of a research institute are research achievements and technological products. The regulation and control measures are organization (including leadership systems, management organs, and personnel), planning (including decisionmaking on task projects), policies (including cadre policies, economic allocation policies, and other policies), and so on. Thus, to improve the operational mechanisms of research institutes, we also must do extensive research in each of these areas, especially on the operational mechanisms of capital, manpower, and achievements. We are now doing special topical research on the following four questions. The main aspects of the research are:

1. Capital operation mechanisms and financial management systems in research institutes, analyzing the current situation in research institute fund income and expenditures and problems in financial management, opening up channels for capital sources for research and management methods for funds for short-term loans, investment methods and financial management systems in research institutes for technological development economic entities run by institutes, systems for allocating rights among research institutes and the economic entities they run, and so on.

2. Personnel work mechanisms in research institutes. We are exploring the question of personnel faults [duan ceng (2451 1461) geological fault] in research institutes, selecting and training superior quality talented young S&T personnel, accelerating personnel circulation and encouraging appropriate research personnel to move into development administration, policies to optimize personnel organization, and so on.

3. The organizational leadership system in research institutes. We are exploring effective organizational leadership systems in research institutes for research operation management systems and technological enterprise management systems, especially leadership patterns and methods in institute-run enterprises.

4. Effects of the external environment on research institute operational mechanisms and management systems and countermeasures. We are analyzing plans and the role of market regulation, the strength of state S&T investments and the effects of relevant policies on scientific research and development work and countermeasures.

Role of Major Institutes in Developing High-Tech Industries

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[Article by Wang Peitang [3769 1014 2768] and Yang Bailing [2799 2672 7881]: "Role of Major Research Institutes in Developing High-Tech Industries"]

[Text] This article analyzes the role, functions, and capabilities of major research institutes in developing high-tech industries by reviewing the situation at the Dalian Chemical Physics Institute. It discusses the outstanding strengths and serious shortcomings of major institutes and argues that the key is creating a new high-tech development system and operating mechanisms. It emphasizes the importance of creating a good social environment and support system.

Since the 1970's developed nations as well as some developing countries have been scrambling to develop high-tech industries, trying mightily to capture and corner the international market. To meet this challenge, the state made high-tech industries its focus in the Seventh 5-Year Plan. The monitoring, research, and development of high-tech accounts for a major portion of the scientific research work at the 1,000 major institutes under the CAS and the various ministries and commissions of the central government. What most concerns people right now is this: How effective really are these institutes in developing China's high-tech industries? What kind of support do they need from society? Based on the practice at CAS's Dalian Chemical Physics Institute, this article discusses ways of utilizing institutes in developing high-tech industries.

1.Assessing the Place, Capabilities, and Roles of Major Institutes

1) Outstanding Strengths Many of China's major institutes were tracking, researching, and developing high-tech back in the 1950's and 1960's. The launching of the "two bombs and one satellite" was the best example. The Dalian Chemical Physics Institute, the same age as the PRC, successfully developed a high-quality aviation fuel in the 1960's, which not only radically improved the combat ability of China's air force, but also generated billions of yuans in profits for enterprises. In the 1970's, it developed a battery for aviation fuel that was the functional equivalent of a similar product used in the American Apollo moon-landing program, creating extremely favorable conditions for the continued development of China's space industry. The space vehicle flight altitude control catalyst series, used successfully in the flight altitude control of several kinds of rockets, guided missiles, and satellites and has been made available to several nations along with matching carrier vehicles. In the 1980's, a hollow fiber membrane nitrite-hydrogen separator was successfully developed, breaking the monopoly in the world. Products from the stage of pilot-plant production have now made their way into the international and domestic markets. Also in the 1980's, a new technology of making Ethylbenzene from catalytic cracking gan qi was developed. Cooperating with factories, we have now moved beyond the 1,000-ton testing stage. This achievement has been hailed as a jewel in the crown of China's petroleum industry.

In the development of China's high-tech industries in the future, what is the potential of Dalian Chemical Physics Institute? What projects will it make available for society to choose? This article does not intend to answer those questions fully but only cites some examples (see table) to illustrate. If Dalian sees these projects through to the very end and receives the necessary support from society, each and every one of them can generate profits to the tune of hundreds of millions of yuan.

The situation at Dalian is a microcosm of the nation's 1,000 major research institutes. Their strengths are epitomized as follows: 1) A treasure trove of intellectual resources for high-tech R&D; a pool of bright S&T minds. 2) The means to carry out high-tech R&D. Many of their laboratories are every bit as advanced as their counterparts overseas. 3) They are a pool of academic knowledge and technical reserves, with numerous achievements and technologies available for use in developing China's high-tech industries. These strengths are a precious asset for the country as well as its pride. It is priceless.

Table 1: Projects and their Anticipated Economic Benefits

Project: Polymer Membrane Separation Technology Can be used extensively in various industries, including petroleum, chemical industry, metallurgy, pharmaceutics, food, and biology. The nitrogen hydrogen separator alone can generate over 200 million yuan in profits. Products may be exported to earn foreign exchange.

Project: New jiaqing ju ester pesticide Lauded internationally as the third generation of pesticide. Production currently monopolized by Japan. A production line with an annual output of 4,000 tons can generate $33.6 million in value. Economic benefits for agricultural production will be even greater.

Project: Anti-pollution coating made of trimethylbenzene tin chloride Key material in the prevention of biological growth and the maintenance of a vessel's seaworthiness. With China's abundant tin resources, we can build a trimethylbenzene chloride production line with an annual output of 10 million tons worth at least 100 million yuan.

Project: Using catalytic cracking to make ethylbenzene from dry gas Use the vast amounts of residual gas from oil refineries to make upscale plastic products after multiple processing. Applied nationwide, this technology can generate over 500 million yuan in output value.

Project: Alkyl aryne catalyst One of the key technologies in the transformation of petrochemical enterprises. Plans are being worked out to develop products jointly with an enterprise. A production line with an annual output of 40,000 tons of polystyrene will generate over 400 million yuan in output value and more than 200 million yuan in taxes and profits.

Project: Urban gas methanization technology Use water gas production equipment and process to put together ordinary-pressure water gas methanization equipment,

thereby raising heat value 30 percent, with enormous economic and social benefits.

Project: Making high-activity manganese hydroxide from natural carbonic acid manganese There is an acute need for this on both the international and the domestic markets. Liaoning alone has 10 billion tons of natural carbonic acid manganese reserves. A production line with an annual output of 100,000 tons of high-activity manganese hydroxide can generate 1 billion yuan in output value and over 200 million yuan in taxes and profits.

2) Serious Weaknesses

In terms of understanding, the emphasis on basic research and the slight for applied research are still a serious problem in some institutes. Some people are interested only in monitoring and developing high-tech, but are unwilling to tackle high-tech product development. 2) As far as the personnel structure is concerned, we have too many academics with their profound learning and high theoretical standards and too few skilful technicians. The shortage of engineers and technologists is particularly acute. 3) When it comes to technological equipment, we have a good number of modern research and experimental facilities with superior equipment. Yet we have no facilities for pilot-plant testing or industrial equipment. Those that do exist are poorly equipped. 4) The basic conditions for turning achievements into commodities are not met. By and large, major institutes lack technical workers, plants and sites, funds, and people skilled in management and business. Under these circumstances, it is no doubt an uphill struggle for them to turn the achievements of high-tech research into products and commodities and profit from economies of scale. Practice proves that Dalian has an array of high-tech achievements that can generate enormous profits. But because of this or that problem, commercialization has been badly hampered.

2. Establish a New High-Tech Development System and Operating Mechanism

Since the introduction of reform and the open policy, a considerable number of major institutes has taken the path of material production. According to reports, the nation's 1,000 major institutes can come up with thousands of high-tech and new-tech achievements, many of them with tremendous potential economic benefits. Given the reality in China today, if we are to translate scientific research achievements into products and put them at the service of the domestic and international markets to the full, we need to take a two-pronged approach. On the one hand, institutes should join forces with competent and energetic enterprises and together turn high-tech and new-tech achievements into high-tech and new-tech products. Of the seven projects cited in this article, this approach would work for four of them. Alternatively, a scientific research institute may take the lead in setting up an integrated system bringing together research, development, production, sales, marketing, and on-site services under one roof. Right now, especially, many large and mid-sized enterprises have little enthusiasm or very limited capability to develop high-tech products, which makes it that much more important for institutes themselves to create and develop high-tech enterprises. Toward that end, it is critical that we accomplish the following:

1) Establish a new high-tech development system that is market-oriented and product-led. This is an issue that developmental and comprehensive institutes should first consider. To accomplish this, they must be resolved to change their scientific research structure and solidly enhance their capability to develop, sell, and market high-tech products, a point driven home by the success of the Dalian Institute in researching and developing the new-tech of membrane separation. Because it put together an appropriate new system, it pulled off three quantum leaps in 9 years—research, pilot-plant production, and industrial experimentation. Not only has the resultant product played a major role in the transformation of China's oil refining industry, but the synthetic ammonia industry has also begun its foray into the international market.

2) Select qualified personnel and achieve optimal combination. The principal activity of the high-tech enterprise is technology development, product development, and marketing. Its team of workers must meet this demand. Instead of simply rounding up the required number of workers, it must consider their mix of specialties and expertise, their skills structure, and their age composition so as to make the most of workers at all levels. In researching, developing, and producing the flight altitude control catalyst, Dalian kept its staffing configuration and all activities in the optimal mode throughout, thereby ensuring successful flight altitude control for the launching of various kinds of rockets, guided missiles, and satellites.

3) Build a production line capable of achieving economies of scale. At present some major institutes lack testing sites and production facilities capable of achieving economies of scale. This is an important reason why they cannot translate many of their high-tech achievements into productive forces on their own. Reviewing how it suffered from this in the past, Dalian was determined to build its very own new sophisticated chemical physics catalyst workshop. After pilot-plant production, its products have already proved vital in the technological transformation of a dozen large and mid-sized enterprises in China.

4) Establish a scientific management system. As proven by practice, whether or not a major institute is able to create and develop its own high-tech enterprise hinges on the following factors, quite apart from the closely-related factors mentioned above: 1) Its leadership's understanding of the creation of a high-tech enterprise and the importance it attaches to it are a precondition for the successful operation of a high-tech enterprise. Once the leadership has the right idea, support will be readily

forthcoming for the institute as it tries to secure the necessary personnel, funding, equipment, site, and other prerequisites and the relationship between the enterprise and the institute can be satisfactorily managed. 2) Select a good manager and let him get on with the job of management on his own. The manager of a high-tech enterprise is the creator and organizer of the newest productive forces. His responsibilities are to lead workers and employees in building a high-tech development system that is full of energy and dynamism and improving the deployment of R&D forces thoroughly to ensure sustained, steady development; develop productive forces by pursuing projects that are dynamic, with market as the target; work the company's entire staff into an "excited state" as much as possible and make full use of each worker's initiative and creativity; and establish wide-ranging ties and cooperation with society, improve its self-development ability continuously, and gradually put together a high-tech enterprise group centered on itself. 3) Deepen reform, establish a scientific management system and a work order that is highly efficient and fast paced. High-tech development and scientific research work differ in developmental goals, activities, rhythm of work, and values. For this reason, we cannot duplicate the old scientific research system and management procedures in the enterprise. Instead, we must establish a set of effective scientific management methods, bearing min mind the actual circumstances. Among these methods should be independent and autonomous decision-making mechanisms, flexible operating mechanisms, a personnel system that makes the most of its workers, a distribution mechanism that compensates an individual in accordance with his work, and an incentive system that mobilizes the initiative of workers so that the enterprise can gradually become a benign system that perpetuates self-development and self-restraint.

3. Establish a Favorable Social Environment and Support System

This is mainly what we can learn from the way developed nations in the world developed high-tech industries: 1) A strong desire to develop high-tech industries; 2) Abundant resources in terms of high-tech achievements and talent; 3) Preferential government policies to nurture such industries; 4) Adequate financial resources; 5) Active coordination and support by society at large. The intelligence, diligence, and loyalty of the S&T personnel at major institutes are not enough to satisfy these demands. To a large extent the development of high-tech industries hinges on the objective environment and conditions.

1) Raise the understanding of the entire nation of the development of high-tech industries. People must be made to understand that one cannot only think of the immediate in doing things, that high-tech industries based on the latest S&T that are competitive on the international marketplace are the best hope for China's drive to catch up with developed nations economically. They must also be made to understand that while major institutes today have on hand a large number of high-tech achievements with enormous potential economic and social benefits, it will be a daunting task to really turn them into high-tech products and achieve economies of scale, a task that will require society-wide coordination and support.

2) Improve macro policy-making by the government and impose successful macro economic regulation and control. Right now China still cannot afford to pour large sums of funds into the development of high-tech industries. The effects of the old fragmented system have not been eradicated and the mechanisms for S&T and economic cooperation are not yet completely in place. Under this situation, macro policy-making and comprehensive leadership by government departments take on additional importance. The formulation of a high-tech development strategy and plan, the creation of high-tech development areas, the selection of priority fields and priority projects, the direction of funding, and the preparation of related policies... in all these areas the government need to step up leadership and carry out successful macro regulation and control and effective organization and management. We mentioned above three high-tech achievements—membrane separator technology, new jiaqing [3946 8642] ju ester pesticide, and anti-pollution coating for ocean-going vessels, which have generated tremendous economic benefits. Only strong support by government agencies at all levels, from central to local, in the areas of funding, raw materials, and production sites has made possible the translation of high-tech achievements into products through the various stages, from laboratory and pilot-plant production to industrial experimentation and mass production.

3) Concentrate on nurturing and developing high-tech enterprises that are highly competitive on both the domestic and international markets. From Zhongguancun in Beijing to Shenzhen in Guangzhou, the entire nation, it seems, is caught up in a frenzy to build high-tech enterprises. On the surface, this is a good thing. Look more closely, and you will see that there are many problems. There are only so many high-tech enterprises and projects that can truly impact national economic development in a major way and can compete successfully on the marketplace. This requires government and economic agencies to judge the hour and size up the situation and be willing to spend generously on high-tech enterprises and projects that they have selected. They should be prepared to give them special preferential treatment in the supply of funds, raw materials, and equipment and in tax matters, even to the extent of granting them special permits which would entitle them to all the preferential treatments given to a foreign-funded company. Strong measures are needed to help the high-tech enterprise achieve economies of scale and develop into a multi-national company.

4) Establish a high-tech business start-up service center. To spare newly-established high-tech enterprises the trouble of spending all day on routines like raising funds, meeting conditions, and public relations, it is imperative

that a high-tech business start-up service center be set up. The center should be responsible for both discharging management functions and offering comprehensive services. Among services the center should offer are circulating information, coordinating plans, organizing cooperation, raising funds, hiring personnel, encouraging integration, regulating the supply of goods and materials to prevent shortages or surpluses, opening up markets, training personnel, assessing enterprises and consulting.

5) Create a favorable environment and draw up and perfect related policies to help expedite the development of high-tech enterprises. So far many localities have drawn up preferential policies for high-tech enterprises, but the proliferation of policies has also meant a lack of standards, which makes them hard to understand. We know from a number of people charged with putting up high-tech enterprises that these are the issues that concern them most: 1) The government should issue high-tech R&D guides regularly; 2) Public bidding be introduced in the implementation of high-tech R&D projects; 3) Lay down clear standards for high-tech enterprises and specify how they are to be graded; 4) Establish channels for supplying funds and materials to high-tech enterprises; 5) Encourage and protect Chinese high-tech commodities and its products; 6) Give the export-oriented high-tech enterprise the special permit that would give it the equivalent of all the preferences enjoyed by a foreign-funded company; 7) Establish a sound and scientific price system for high-tech products; 8) Encourage talented scientific and technical personnel to join high-tech enterprises. 9) Give high-tech enterprises the authority to hire their own technical staff. 10) Organize contests and competitions to identify the most advanced.

[Responsible editor: Lian Yanhua [6647 3601 5478]

National Key Laboratories Plan Reviewed

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[Article by Liu Sa [0491 7366]]

[Text] The National Key Laboratories Plan was devised in 1983 and was put into implementation beginning in 1984. The country has spent a total of some 500 million yuan, has imported a series of advanced instruments and equipment, and has arranged to have 71 national key laboratories built. The building of these laboratories has stabilized thousands of elite personnel in basic-research and applied-research fields and high-level research results have been achieved. Significant results have also been obtained in the implementation of the policy of "openness, integration and mobility."

In the National Key Laboratories Conference convened in April this year, some famous scientists have pointed out that the building of the National Key Laboratories system is a milestone in the development of China's science and technology and is an important measure in the reform of the nation's science and technology system. People in responsible positions at the State Education Commission, State Science Commission, The Chinese Academy of Sciences (CAS), the Ministry of Agriculture and the Ministry of Health have also given high marks to the National Key Laboratories Plan in their respective speeches. It can therefore be said that the building of the National Key Laboratories has motivated the hearts of the nation's scientists and engineers.

How was the National key Laboratories Plan devised? In 1982, the Party Central Committee proposed that emphasis must continued to be placed on basic and applied research. At the same time, the Central Committee also established the policy of steady development.

In our country, the backbone of our basic research is in the universities and in CAS. Bringing their laboratory equipment up-to-date is a fundamental issue in preserving the vitality of the basic-research effort and in stabilizing the backbone strength and is the essential means to provide youths with the channel of continuity. Accordingly, the State Planning Commission, based on the opinions of scientists and experiences learned from other countries, devised the National Key Laboratories Plan at the end of 1983 and the plan was implemented in 1984.

The management methods adopted by the State Planning Commission on the advice of specialists stipulated that the National Key Laboratories need to face the whole nation, and implement the management mechanism of "openness, mobility and integration." For instance, a person has a new academic idea and a feasibility plan to put his new idea into practice. In the past, the person's idea and plan would probably be shelved because the unit he belongs to does not have the proper laboratory conditions. However, the National Key Laboratories Plan now can create the conditions for him, and bring him to the laboratory for regular work. This is particularly so in the case of researchers at science and technology institutes and universities in remote and backward areas of the nation. In the past, these researchers' applications for National Natural Science Foundation funds was rejected very often because they do not have the conditions. Now these people can bring along with them the national foundation endowments to the laboratories they like and work there. This will break the grip of "relative regeneration" and is advantageous for the development of science.

Now, the National Key Laboratories Plan has entered its 7th year of implementation; the nation has invested over 500 million yuan and has built 71 national key laboratories over this period of time. Of these laboratories, 34 have passed the national approval inspection and are now open [to outside researchers] nationally and internationally, 17 of them are still under development and are in the open category and 20 of them are under development and do not have the conditions for opening up yet. These laboratories are mostly located in universities and in CAS. Later on, the program was expanded into the Academy of Agricultural Sciences and the

Academy of the Medical Sciences; and these laboratories account for about 18 percent of the total.

The building of these high-level laboratories has stabilized a research brigade of about 3000 people. Many science researchers regard working in the national laboratories as an honor—as making a contribution to their mother country. Take, for example, the three researchers of the like of Peng Ping'an in the Organic Geochemistry Laboratory. These three youths were asked to stay by foreign countries for their important research results while doing a joint research project with foreign countries. However, all three of them were willing to return back to their mother country to make further contributions. Now, two of them are already back in the country and the third will also return soon. Peng Shuhua, of the Virus Genetic Engineering Laboratory, went overseas after the disturbances. She treasured very much the opportunity to undertake high-tech research projects in the laboratory and returned to the mother country in less than half a year to be back to her work.

Good laboratory research conditions have enabled science researchers to attain results at the international state-of-the-art. Since 1987, some 20 projects have been awarded the national First Prize for their results and some 30 projects have been awarded the Second Prize for their results. Under the leadership of CAS Academic Committee member Zou Chenglu, the Biological Macromolecule Laboratory has attained a leading position internationally in research on the flexibility of active sites in enzyme molecules. Under the leadership of Feng Duan, CAS Academic Committee Member, the Solid Microstructure Laboratory's research into the common phase in ferroelectricity has won high esteem from international counterparts. Under the leadership of scientists Li Zhengming, the Element Organic Chemistry Laboratory has produced results that has propelled the development of our nation's agricultural pesticides to save the nation US$6 million in foreign exchange in the 2 years of 1988 and 1989.

Moreover, the National Key Laboratories have also played a very important part in developing and nurturing middle-aged and young talent. According to one statistic, over the past years, the National Key Laboratories have trained over 700 Ph.D. students and 3000 master's-degree students. A relatively large number of people have become the backbone of science research. Under the guidance of his instructor, Ph.D candidate Xu Dong of the Crystal Materials Laboratory at Shandong University has created the internationally latest new ultraviolet non-linear optical material. The new material has won recognition from foreign authorities in the field as "one of the six most promising crystals internationally, with applications in such important areas as laser nuclear fusion." In the Protein Engineering and Plant Genetic Engineering Laboratory under the leadership of the 29-year-old Professor Chen Zhangliang, there are a total of 40 young researchers, graduate students and post-doctoral students, all under 30 years of age and all working in the area of plant genetic engineering. They have achieved important progress in applying the anti-plant-disease methods acquired in plant genetic engineering to tobacco and tomato growing.

The National Key Laboratories has also achieved certain results in implementing the policy of "openness, integration and mobility." According to a survey of some 51 laboratories which are open nationally and internationally, over the past 4 years, some 2000 visiting researchers have arrived at the laboratories to do research, some 200 foreign scholars have come to the laboratories to do research jointly with our people and some 1000 foreign scholars have been welcomed to give lectures and visits. Many laboratories have also organized several academic conferences of domestic or international scope. This carries special significance in breaking the departmental grip and promoting academic exchanges.

To make the laboratories the "leading institutions domestically and the institutions with a voice internationally," a greater effort must be made. This is the unanimous view of the leadership and of the experts. Take, for example, in the implementation of the policy of "openness, mobility and integration," there are still deficiencies. This is because the level of openness and the number of visiting researchers have not reached the specified requirements. The number of really high-level, high-integration projects is still too small. The reasons for this are poor logistical support and the lack of funds for opening up the laboratories. To solve these problems, greater attention from the managing ministries and departments are needed. Besides, the various laboratories should raise the quality and quantity of their research to obtain national research assignments and to acquire support from the National Natural Science Foundation. The laboratories can also cooperate with the production departments and accept research assignments of joint research projects.

In the "Eighth 5-Year Plan," according to the nation's macro policy-making and overall planning, our nation will continue to build more national key laboratories. We can foresee that these national key laboratories, either under construction, already constructed, or to be constructed, will play an increasingly important role in the national economy and social development.

Colleges, Universities Well Suited to Help Develop High-Tech Industry

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[Article by Zhu Liming [2612 2621 7686]: "Role of Colleges and Universities in Developing High-Tech Industries"]

[Text] This article discusses the role of colleges and universities in providing technology, qualified personnel, and information, among other things, for high-tech enterprises. It analyzes the various strengths of colleges and universities that can be put to work in

developing high-tech enterprises. Such strengths should be exploited to expedite the development of China's high-tech enterprises.

The high-tech industry is the leading industry in the industrial structure of the future. Historical experience shows that the development of high-tech industries is closely related to colleges and universities and that the latter play a key role in the maturing of high-tech industries. Tapping their potential to the full will help accelerate the development of high-tech industries.

1. The Substance and Characteristics of High-Tech Industries

The high-tech industry is a concept that everybody defines differently. R. Nelson, an American scholar, puts it this way, "So-called high-tech industries refer to those industries that require massive inputs in terms of R&D funds and are mainly characterized by rapid technological progress." The authoritative magazine "High-Tech" says, "High-tech industries essentially rely on two major characteristics. They have an exceptionally large proportion of specialized technical personnel and plow back a substantial percentage of sales earnings into R&D." These characteristics actually reflect the knowledge-intensive nature of high-tech industries. From the economic perspective, high-tech industries are industries with a high added value and a fast growth rate. Internally, high-tech industries consist of technological and economic aspects. Externally, they refer to the information industry, the new materials industry, marine industries (including offshore drilling and the recovery of uranium from sea water,) space industry (space navigation, space exploration,) new energy industries, and biotechnology. Apart from the above-mentioned characteristics—knowledge intensiveness, high added value, and a fast growth rate, high-tech industries have other special features such as high investments, high risks, high profits, and fast turnover.

2. Colleges and Universities as the Source of High-Tech

1. Colleges and universities are the "technological seed" centers for high-tech industries. To a large extent, the "technological seeds" relied on by high-tech industries are provided by the scientific research institutes of colleges and universities. The role of colleges and universities as the "technological seeds" centers for high-tech industries is epitomized by the large number of high-tech development areas centered on them. In essence, the high-tech area is an organization integrating science research with production. Hence its appeal to many enterprises. Within a high-tech area, colleges and universities disseminate technology by transferring scientific research achievements to high-tech enterprises they run themselves or to other enterprises. This way they function as "technological seeds" centers. An important reason why high-tech industries have developed and flourished is the steady stream of technological seeds from colleges and universities.

2. Colleges and universities as the center of high-tech industrial pioneers. The close relationship between high-tech industries and colleges and universities manifests itself also in the fact that the latter have provided high-tech enterprises with a host of high-caliber industrial pioneers. The founders of many high-tech enterprises come from the ranks of scientific researchers in colleges and universities. Since they are familiar with the research developments in high-tech projects and have a fairly broad technical vision, a solid grounding in scientific research, and a strong sense of starting a business, they are more likely to succeed in running a high-tech enterprise.

3. Colleges and universities as the source of knowledge for high-tech enterprises. Since knowledge-intensiveness is one of the hallmarks of high-tech industries, this means that their development requires an army of high-caliber S&T personnel. It is generally believed that the R&D departments of high-tech industries require five times as many S&T personnel as traditional industries and that over one third of the workers needed by high-tech enterprises are college graduates. By supplying graduates and providing technical consulting and training, colleges and universities are the fountainhead of knowledge for high-tech industries.

4. Colleges and universities as a high-tech information collecting and distributing center. Time is of the essence in the development of a high-tech industry, whose life-span can be very brief. Hence the critical importance of obtaining and processing information promptly. As far as high-tech enterprises are concerned, only by getting hold of high-quality technical information and commodity information can the risks of policy-making be reduced. The effective collection, storage, analysis, development, and utilization of information is a basic prerequisite for the growth of a high-tech enterprise. The college or university, particularly the technological research center and laboratory jointly operated with industry, is a major base for high-tech R&D and for basic research, the place of origin of high-tech information where new inventions, new technologies, and new ideas surface endlessly. Moreover, colleges and universities conduct high-level S&T exchanges, domestic and overseas, on a long-term basis and have collected a vast body of high-tech information. All this makes them information collecting and disseminating centers.

3. Potential Strengths and Roles of Colleges and Universities in Developing High-Tech Industries

Colleges and universities play a pivotal role in the development of high-tech industries. This is true whether you look at the experience of the development of high-tech industries in developed nations or the inherent features of those industries. When it comes to high-tech industries, China is a latecomer and lags both in the scale of the industries and in technological standards. Thus we must work hard to tap and utilize the enormous potential strengths of colleges and universities. Essentially these are their major strengths:

1. Strength in multi-disciplinary comprehensive research. A major feature of high-tech industries is that they are highly comprehensive. A high-tech industry often results from a series of comprehensive studies, rather than advances in just one discipline. This is because modern S&T has been advancing in two directions—vertically and horizontally, thus setting up a trend toward continuous fragmentation and integration. Any progress in high-tech requires cooperative and comprehensive multi-disciplinary research. As George Keyworth, a former presidential scientific adviser of the U.S., said, "Today's high-tech is invariably the result of overlapping scientific developments, of bringing together S&T in various areas." Advanced ceramics, for instance, involves solid state physics and chemistry, on the one hand, and metallurgy and mechanical engineering, on the other. It so happens that colleges and universities have the potential ability to conduct comprehensive research, thanks to their full line-up of disciplines, which are closely related to each other. At present there are 1,063 colleges and universities in China, including about 100 which are particularly strong in some disciplines and conduct scientific research at advanced levels, offering almost 900 courses. This bumper crop of disciplines sets the stage for comprehensive research. Besides, as part of their horizontal associations with other institutions of higher education and enterprises, these colleges and universities are giving birth continuously to a series of new disciplines, particularly cutting-edge disciplines and overlapping comprehensive disciplines, in order to meet the needs of high-tech research. In short, with their plethora of disciplines, colleges and universities are well positioned to bring together experts from a multitude of disciplines to conduct high-tech research and, by exchanging information and filling one another's knowledge gaps, improve the efficiency of high-tech research and accelerate the development of high-tech industries.

2. The strength of colleges and universities as a pool of intelligence. A large concentration of high-qualified personnel is the mainstay of high-tech industries. And colleges and universities are precisely where intelligence is concentrated, a supply center of the intellectual resources indispensable to the development of high-tech industries. There was a total of 1,063 colleges and universities in China in 1987, with a combined enrolment of 19.59 million students, including 119,000 graduate students, and a faculty of 385,000, including 77,000 associate professors and above and 133,000 lecturers. Colleges and universities also boast 178,000 R&D personnel, including 161,000 scientists and engineers. This S&T army, which is vast in number, large in scale, and formidable in ability, is armed with advanced equipment and skills to do experiments. It constitutes a fountainhead of technological innovations and inventions. Between them, the 756 colleges and universities engaged in R&D published 3,228 S&T monographs and 63,016 academic papers, had 6,063 achievements appraised, registered 4,882 patents, and signed 74,699 contracts on technology transfer in 1985, fully demonstrating their strength as a concentration of intelligence.

3. The high efficiency of colleges and universities in R&D is another strength. A major characteristic of the development of high-tech industries is their high efficiency and this is where colleges and universities are well suited to develop high-tech R&D. In colleges and universities, R&D inputs are small while the output are considerable. Scientific research achievements are of a high quality. Colleges and universities are much more efficient in R&D than ordinary R&D institutions.

Besides conducting regular basic research, colleges and universities in China have set up a host of scientific research organizations based on the fields they are strong in and their scientific research tasks. According to 1987 data, colleges and universities had 1,514 scientific R&D organizations in all, with a total of 178,292 R&D personnel, about 46.3 percent of all faculty members. While the funding inputs were limited, the outputs were substantial. In 1985, for example, R&D spending was 678 million yuan. On the output side, there were 63,000 academic papers and 73 approved patents. The ratio between R&D spending by these R&D organizations in colleges and universities and R&D spending by other independent R&D institutions for the same period was 1:11.6. Corresponding figures for academic papers published and patents approved were 2.2:1 and 3.3:1, respectively, making the former notably more efficient than the latter. Moreover, colleges and universities captured 34.4 percent of the natural science awards approved in 1982. Of all invention prizes approved by the state between 1979 and 1986, colleges and universities accounted for 25.1 percent. Of the 1,302 natural S&T prizes in 1985, colleges and universities took 12.5 percent. In the same year, they won 904 prizes awarded by ministries and commissions in the State Council, 1,437 prizes awarded by provinces, municipalities, and autonomous regions, and other 1,304 prizes, and transferred technology worth 130 million yuan. During the Sixth 5-Year Plan, the 31 colleges of science and engineering, agricultural universities, and medical schools directly affiliated with the State Education Commission came up with 6,361 theoretical achievements and applied technical achievements, of which 157 were international innovations, 784 reached advanced international levels, 1,080 were domestic innovations, and 2,497 reached advanced domestic levels. Their performance was truly outstanding.

4. Colleges and universities as depository of high-quality information. The development of high-tech industries, necessarily accompanied by information processing, is inseparable from the collection and processing of high-quality technical information. Information is an important resource for the development of high-tech industries. High-tech competition is essentially competition for qualified personnel and competition for information. Only when we make information a top priority, absorb high-tech information continuously, and raise the technological standards of industry can we be certain of

sustained development. Colleges and universities have the technical capability and material equipment to develop information resources and are also a source of high-tech information themselves. Moreover, they have numerous channels for obtaining information, which means that they are where high-quality information gathers. At present the strength of China's colleges and universities in this respect demonstrates itself primarily in the following ways: 1) R&D activities, which are heavily concentrated in colleges and universities, have produced a large amount of high-tech information. Of the almost 400,000 teachers in China, about 40 percent participate in scientific research. Additionally, there are 100,000 graduate students. All of them produce a body of high-quality scientific research achievements, which are the principal source of information. 2) High-tech academic exchanges in which colleges and universities are involved enable those institutions to pool high-quality S&T information. Colleges and universities are communities whose members display a high degree of mobility. Many of their graduates are widely dispersed at home and abroad among many sectors but maintain extensive informational ties with their alma maters. Moreover, academic exchanges and cooperation among colleges and universities and between colleges and universities, on the one hand, and enterprises and scientific research organizations, on the other, have also enabled colleges and universities to accumulate the latest S&T information. Besides, Chinese colleges and universities have been increasing cultural and academic exchanges with the world, sending large numbers of personnel abroad on study missions and to attend international conferences, lecture, conduct joint research, take refresher courses, and study for a degree, and playing host to many foreign scholars at the same time. This is a highly effective approach to keep abreast of S&T information. 3) Colleges and universities are equipped with high-quality information processing equipment and personnel in large quantities. Most of China's colleges and universities have computer centers of an appropriate size and are equipped with computers, large, medium, and small, as well as microcomputers. They are also manned by computer R&D personnel. Most of the senior computer personnel can also be found in colleges and universities. Accordingly, the information processing systems in colleges and universities are easily compatible with various types of information centers in the world. College or university libraries are another major source of information resources. In short, China's colleges and universities are a pool of information, which positions them well in the development of high-tech industries.

5. A compatible culture. The development of high-tech industries requires a compatible high-tech cultural milieu. Rogers, author of "Silicon Valley Fever," wrote, "High-tech culture is a different culture. It is a way of life that people find it hard to understand. When the development of high-tech industries is incompatible with the social culture, it will cause a string of social pathologies, such as spiritual emptiness, a weakening in interpersonal relationships, rising divorce and suicide rates, and increasing incidence of mental illness. Colleges and universities can provide the soil for the growth of a high-tech culture. The large number of qualified personnel are of a high caliber and psychologically well adjusted. They have an arduous pioneering spirit and the courage to take risks. There is an eagerness to pursue human values, efficiency, and competition. They have a higher regard for the inner quality of life and take the human being as the center of things. There is the freedom to create independently. They value individual creativity. They also have multi-cultural values and an ability to adapt to and accommodate social change. Overall, colleges and universities are characterized by diversity and openness. They are also human-centered, innovative, highly efficient, and flexible. Consequently, they are suited to the development of high-tech industries.

(Responsible editor: Jiang Shihuo [5592 0013 0735])

Structural Reform in Research Institutes To Follow 'One Body, Two Wings' Development Model

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[Article by Xia Guofan [1115 0948 5672]: "Structural Reform In Research Institutes to follow 'One Body, Two Wings' Development Model"]

[Text] In carrying out S&T structural reform, a number of industrial research institutes have established and improved the "one body, two wings" model. This article begins by discussing the characteristics of this particular management system and then proceeds to analyze and examine how we can realize the goal of making scientific research the mainstay part, improve the methods of pilot-plant production, and do a good job in S&T management.

As S&T structural reform intensifies steadily, scientific research units such as the independent industrial research institutes and Research Institute 608 of the Ministry of Aeronautics and Astronautics as well as the Electric Locomotive Institute of the Ministry of Railways, all in Zhuzhou, have gradually established and improved the "one body, two wings" development model. Below is a concise analysis of the practices, approaches, and detailed measures that these scientific research units have taken in their practice of reform.

1. Major Characteristics of "One Body, Two Wings" Development Model

"One body, two wings" means "taking scientific research as the backbone, and pilot-plant production and S&T management as the two wings." As applied to industrial research institutes, this development model operates at clearly distinct levels, allocates resources down tot he lowest level, ensures a reasonable distribution of labor, and is well coordinated.

"One body, two wings" is guided by the principle that "economic construction must rely on S&T and S&T work must orient itself to economic construction." Its principal goal is to promote the industrial economy, the defense economy, and the national economy by mobilizing our vast S&T forces. It operates at three levels and struggles valiantly to make contributions.

At one level is the drive to continue to intensify basic research and applied research. Our ability to conduct such research and our standards in such research is a major criterion in assessing the nation's overall strength and military power. As an independent industrial research institute preparing in advance to meet the economic and technological competition of the coming 21st century, we must firmly implement the CPC Central Committee's policy of "developing basic research steadily" and the principle advocated by the defense S&T industry: giving priority to preparatory research. Let basic research and applied research take center stage, use the best people, and make adequate investment to ensure staying power for the development of command scientific research plan, armaments advance research, and scientific research and to ensure the quality of scientific research achievements. We should produce a steady stream of new S&T achievements and strive to come up with high-tech achievements at the forefront of the world. In Zhuzhou, for instance, 12 specialized research institutes have introduced the "one body, two wings" model. Within 2 years, they won more state, provincial, and municipal S&T progress awards than in the previous 4 years combined. In recent years, Research Institute 608 has made sold progress in the pre-research of new planes, in model R&D, and in testing new technologies, thanks to a large extent to the catalytic effects of the "one body, two wings" development model.

On another level we track and develop high-tech and establish new-tech and high-tech industries. High-tech is a body of new tech at the frontier of modern S&T that builds on basic research and applied research and guides the development of social productive forces and the build-up of the nation's military power. High-tech industries are industries where high-tech achievements are the primary technical component and resource input and which make products with a high added value. An industrial research institute demonstrates its growth mainly through new products and new models. In particular, it must tackle the tracking and development of high-tech, the making of high-tech products, and the creation of high-tech industries as a strategic mission. Since the "one body, two wings" development model is woven into the entire process, from theorizing to putting a product on the market, from S&T R&D and commodity development to the development of production capability and market development, it embodies the management principle of integrating S&T research with trial production and marketing. Like a number of well-known economic and technical entities that are S&T pacesetters such as Bell Labs and Dupont Company, "one body, two wings" encompasses everything from the beginning to the end, from scientific research through intermediate testing and batch production to marketing. As such it greatly facilitates the effective of high-tech achievements and the formation and development of high-tech industries.

At yet another level we must increase scientific research output and do our utmost to serve economic construction and defense construction. Generally speaking, scientific research output consists of two parts, namely scientific output, including theoretical achievements and technical achievements, measured in both quality and quantity, and technical output, that is, the social and economic benefits resulting from the conversion of technical achievements. Increasing scientific research output will make scientific research serve the present national economy even better. According to "A Comparative Study of S&T Development in China, India, and Brazil" put out by the Chinese S&T Information Institute, China spent about 1.6 percent (1985) of its GNP on S&T research, compared to less than 1 percent in India and Brazil, but although China is No 1 in S&T spending, its scientific output is less than that of India. In terms of the principal vehicle of scientific output—the research paper, China's is one third of India's. When it comes to technical output, China is outperformed by Brazil, whose industrial productivity is three-fold that of China and whose agricultural productivity is 5.8-fold. The reasons for this are manifold, but the past failure by scientific research units to develop the "one body, two wings" model and convert scientific research achievements into productive forces is undoubtedly one of them, as proven by the scientific research practice of Research Institute 608. Because it stuck to the "one body, two wings" model, Institute 608 made 15 million yuan in gross earnings and over 2 million yuan in net earnings in 1988. According to incomplete data on five institutes in Zhuzhou, including the Zhuzhou Chemical Industry Research Institute, their annual combined earnings from scientific research exceed 21 million yuan, including 5.2 million yuan, in net earnings. On the one hand, they have contributed to enterprise technological transformation, the development of the nation's industries, the improvement of China's military combat ability, and the promotion of socialist modernization. On the other hand, they have generated enormous social economic benefits. This shows that the emphasis by research institutes on the "one body, two wings" model will certainly put an end to the "high inputs, low outputs" situation in S&T and create an economic mechanism oriented to efficiency in S&T.

2. Create a General Environment Where "Scientific Research Is the Mainstay"

The experience of Zhuzhou in establishing and improving the "one body, two wings" operating mechanism tells us that to adhere to making scientific research the mainstay is to stick to the institute's direction of professional development and the armaments scientific research structure and enhance the institute's technical

reserves and staying power. To meet this demand, it is imperative that a general environment where "scientific research is the mainstay" be created.

1. Provide an ideological guarantee for taking "scientific research as the mainstay."

Scientific research is the fundamental responsibility of a reserve institute. Accordingly, the institute must overcome the tendency to pursue immediate or short-term profits, behave short-sightedly, and go after projects that have a short turnover period, require little investment, and pay off quickly. Whatever the size of the research project in question or the amount of funds invested, there can be no departure at all from the idea of making scientific research the mainstay. Pilot-plant production and S&T management must also be regarded as an extension of scientific research activities.

2. Guarantee that qualified personnel would be available to ensure that "scientific research is the mainstay."

Qualified personnel are the cornerstone of scientific research. Currently the corps of workers in basic research is shrinking as core scientific researchers are leaving in droves. In the course of establishing and improving the "one body, two wings" development model, everybody agrees, an appropriate policy to protect qualified personnel should be formulated and their terms of service should be improved. 1) Allow a specified percentage of the operating expenses for scientific research projects and armaments projects to be set aside as incentive funds to reward S&T personnel in basic research. 2) Bonuses for S&T personnel who have made major contributions to key projects and armaments model should be increased by a specified percentage on top of the average level for all personnel. 3) When a person works overtime to complete a task in time or over-fulfills his work quota, he should be compensated appropriately for his after-hours work. That way we will be able to attract an army of competent workers who follow closely the direction of socialism and are dedicated to the cause of scientific and defense research. It will be the job of this army, which should be structurally sound and suited to modern scientific development in the world, to conduct scientific research and track high-tech. The army of workers should have an appropriate degree of stability even as qualified personnel enjoy a reasonable amount of mobility.

3. Guarantee that funding would be available to "make scientific research the mainstay."

Since the beginning of the 1980's, countries all over the world have significantly increased investment in basic research as economic development became more dependent on scientific breakthroughs. In America, basic research accounts for about 12 percent of total R&D funding. Corresponding figures for Japan, West Germany, France, and Eastern European nations are 14, 20, 20, and 11-13 percent, respectively. In India, S&T spending is less than half of that of China, but its basic research spending doubles China's and the scale of applied research is also much larger than ours. In 1987, China's total investment in basic research amounted to about 800 million yuan, 7.1 percent of he nation's budgetary allocations for science and technology, far below the average in the world. To adhere to "making scientific research the mainstay," we should increase the ratio of investment in basic research from the current 7.1 percent to 9 percent by the end of the Seventh 5-Year Plan and then to 10 percent during the 1990's, depending on the nation's fiscal state. In the case of armaments scientific research, funds may be obtained by applying to the S&T development fund and by entering into a lateral contract with the principal contracting unit. Another source of funding is the user who commissions the project. Within the research unit, an institute director selection fund may be set up. Research that explores new ideas and searches for new technical approaches should receive support from that fund on a selective basis after review by the S&T committee and with the permission of the institute director. This way an environment and climate favorable to "making scientific research the mainstay" will come into existence.

3. Strengthen the Tools of Pilot-Plant Production in Various Ways

Pilot-plant production, one of the "two wings," is a key stage that a scientific research unit cannot bypass as it puts a new product or new technology through the process from scientific research through preliminary testing to industrialized production. It is a vital link between S&T progress and economic development. On the pilot-plant production line, not only can we carry out the trial manufacturing of prototypes and specimens and small commercialized batch process, but we can also solve technical problems in production. When a new technology is transferred to the enterprise and disseminated after the results of pilot-plant production are reviewed, the entry of high-tech industry into economies of scale will be accelerated. Thus the industrial research institute must comply with the spirit that informs the instruction in the "Decision of the CPC Central Committee on S&T Structural Reform:" "Develop in S&T institutes a capacity for self-development and for serving the economy on their own initiative." It must improve the tools of pilot-plant production in various ways and enhance its technical development ability. Based on the practical experience of Research Institute 608 and the Zhuzhou area, these are the major approaches:

1. Self-Development Type

Under this kind of self-development, a scientific research institute develops a trial-manufacturing capability compatible with and oriented toward economic construction, thus making itself "small but capable." This kind of self-development differs from the isolated variety under which a unit aims to achieve a full lineup of industries despite its small size. The pilot-plant production line requires equipment and quality-testing methods, which means that it needs more investment than the scientific research stage. In some countries, the

investment ratio between scientific research, intermediate production, and batch production is 1:10:100. While this ratio is not necessarily suitable for China, the state should support and help research institutes improve their intermediate production ability: 1) The state should incorporate pilot-plant production projects into projects that receive specialized allocations. The main source of funding should be capital construction funds. 2) Pilot-plant production sites should be exempt from building taxes and the necessary equipment and apparatus should also be exempt from import tariffs and industrial and commercial regulating taxes. 3) Increases in electric capacity at pilot-plant bases should be free of charge in part or in full. 4) Raw and supplementary materials, fuels, and parts and components used in experiments and pilot-plant production should be incorporated in the market regulation plan to be supplied by the goods and materials agencies on a preferential basis. 5) The state should draw up tax exemption regulations for pilot pant products and pilot-plant achievements and work out policies to encourage the conversion of S&T achievements into products. With funding assistance from the state and funds rased by itself, Institute 608 has built a pilot-plant production line whose functions include the making of semi-finished products, rebiao [3583], jijia [2623 0502], jidong [2623 0520], and general assembly. Add the necessary high-precision and multi-function numerical control equipment, and we will have a basically complete pilot-plant production line.

2. Absorb-An-Enterprise Type

This means that with its strength in high-tech and its new products, the scientific research unit is able to attract a well-qualified enterprise into it and turns it into a pilot-plant production base by investing in it the necessary funds and equipment. With the support of the municipal government, research institutes in the Nanjing area that are affiliated to the ministries or the province have set up 14 pilot-plant bases by absorbing enterprises that are well equipped to undertake production or are technologically strong. In so doing, they have both expedited the conversion of S&T achievements into commodities and promoted economic development in the Nanjing area.

3. Same-Trade Association

This means that the industrial research institute joins an enterprise or enterprise group in the same trade. The enterprise or enterprise group will provide the conditions for pilot-plant production or undertake the trial-manufacturing of pilot-plant products itself. This is a feasible approach toward R&D as it targets specifically the enterprise's development needs. At a time when the enterprise is economically weak or lacks strong related products, the institute that joins an enterprise or enterprise group must select its own research projects, searches for its own markets, undertakes its own tasks, makes its own decisions, assumes its own risks, and orients itself to the economy conscientiously even as it completes technological development projects assigned by the enterprise or enterprise group involved. For this reason, it is important that we keep this type of research institute relatively independent and give it the status of a scientific research legal person so that it can derive incomes from scientific research projects and other consulting work it may undertake for outside units. That way it has an independent source of R&D operating funds and will be able to improve its pilot-plant production facilities as well as its workers' benefits and other conditions of employment.

4. S&T Management Must Combine Technology Orientation With Market Orientation

S&T management, the other "wing," helps determine the research institute's fortunes and survival. If we do a good job in S&T management, we will help shorten the time lag between the appearance of a S&T achievement and its application in production. It is a specific step in the transition of the research institute from pure research to S&T management. The "one body, two wings" experience in the Zhuzhou area tells us one fact, namely that S&T management must adhere strictly to the principle of combining technology orientation with market orientation.

1. To be scientifically oriented in S&T management means making people more scientifically-minded, more technologically conscious. It means using one's strength in technology and equipment to monitor S&T "commanding elevations" of the late 20th and early 21st centuries. It means increasing basic research in engineering technology that is relatively versatile as well as military-plan pre-research and avoiding acting in a profit-driven but short-sighted manner, like a hungry person who cannot afford to be choosy about what he eats. To be technologically oriented is to enhance the strength of the research institute, build up a reserve of technology, and rely on the thrust of technology to ensure that difficult projects are tackled, that pilot-plant production start at a high plane and that S&T achievements are of a high standard.

2. To be market-oriented in S&T management is to make people more commodity economy-minded and more conscious of market competition. Before we implement the scientific research plan, care must be taken to select those research topics that are highly practical, that are compatible with military strategic goals, and that dovetail with model R&D. During the stage of pilot-plant production, even as the research institute undertakes trial manufacturing in accordance the user's detailed design and technical specifications, it must strive to expand exports, starting with import substitution, and participate energetically in world competition based on information on the demand of the domestic and foreign markets. At the selling end, we must do a good job in the transfer of intellectual products, namely scientific research achievements, and the marketing and services of tangible products, namely the products of pilot-plant production. S&T achievements must be commercialized

further, the pulling force of the market must be relied on, and the trend toward making and exporting marketable products to earn foreign exchange must be maintained.

In short, make market the goal of technological orientation and guide market orientation with technology. Combine the two at high-level R&D to expedite the reform of scientific research units and the transformation of their operating mechanisms. This will certainly create a new look in the industrial research institute, one featuring high-quality achievements, abundant technological reserves, fast technical development, pilot-plant products with high added value, and high scientific research outputs.

(Responsible editor: Lian Yanhua [6647 3601 5478])

Aging of S&T Personnel Will Be Major Problem by Year 2000

90FE0290H Beijing KEYAN GUANLI [SCIENCE RESEARCH MANAGEMENT] in Chinese No 4, Jul 90 pp 28-31

[Article by Hou Yimin [0186 6654 3046] of the Chinese Academy of Sciences Science and Technology Policy and Management Science Institute: "A Preliminary Exploration of the Problem of Personnel Faults and Aging and Solutions"]

[Text] **Abstract**

This article begins with several surveys of typical importance to do quantitative analysis of the personnel situation in the Chinese Academy of Sciences [CAS] Zhongguancun region, six key Chinese institutions of higher education, and the Shenyang Branch of the CAS. It points out the seriousness of personnel faults and personnel aging and offers some policy suggestions.

The CAS is China's national team in natural science research. Personnel faults and personnel aging have already become extremely urgent.

On the basis of estimating current conditions[1] and considering average lifespans (Note: The results of the 1987 population census by the State Statistics Bureau indicate that the average lifespan in China has risen to 69 years and almost 70. See the speech by Ministry of Public Health minister Chen Minzhang [7115 2404 4545] in JIEFANGJUN BAO [PEOPLE'S LIBERATION ARMY DAILY], 9 Mar 90), natural personnel reductions, and prerequisites of arrangements in all units, I focused on 41 units in the CAS Zhongguancun region that have one-third of the CAS' S&T personnel to project the age structure of middle-aged and elderly S&T personnel in the year 2000. People aged 45 to 59, who now comprise two-thirds of those formally on staffs, will reach the 55 to 69 age group at that time, so many of them will have to retire (see Figure 1). The work of these people will have to be continued by comrades who participated in work after the 1970's. Several problems exist both in the quantity and quality of these personnel. The foundations of undergraduate and graduate students who entered the CAS during the 1980's are acceptable, but there is a serious outflow of people from this generation for various reasons.

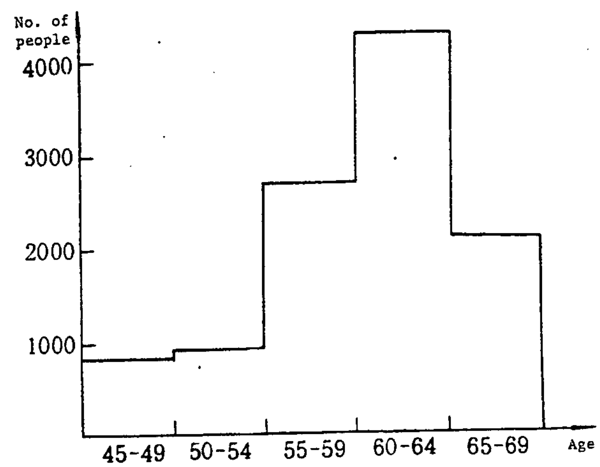

Figure 1. Projected Age Structure of Middle-Aged and Elderly S&T Personnel in 41 CAS Institutes in the Zhongguancun Region in the Year 2000

The situation is similar in institutions of higher education. According to a survey of the age structure of professors at Qinghua University, Beijing University, Beijing Aviation and Aerospace University, Beijing Posts and Telecommunications College, Beijing Science and Technology University, and Beijing Science and Engineering University, 60 percent of people aged 46 to 60 now on their staffs will enter the 56 to 70 age range in 2000, so many elderly professors will be retiring (see Figure 2).

Although this is a static estimate and circulation of these people was not taken into consideration, who wants to make the optimistic guess that many other organs will be willing to absorb these elderly intellectuals as formal staff members in the next 10 years? State-run organs will be unwilling and civilian organs will not do so. Circulation of elderly personnel is certainly not an easy thing. Age levels of S&T personnel in these six institutions of higher education and the 41 institutes in the Zhongguancun region can reflect the situation in key organs in China that take on high technology tasks. Their development has basically been concurrent with growth of all the research organs under central ministries and commissions in new China.

The results of a sample survey of 43 units by the CAS Cadre Bureau indicate that research office directors aged 51 to 59 now account for 65 percent of the total number of research office directors while office directors 45 and under account for just 4.3 percent. Study group leaders aged 51 to 59 account for 52.5 percent and those 45 and under for just 12.1 percent. Aging of personnel in the

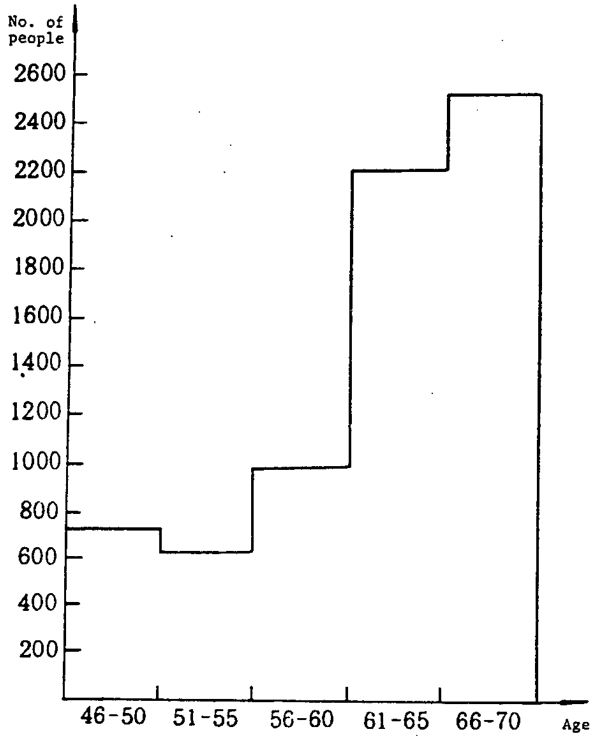

Figure 2. Projected Age Structure of Middle-Aged and Elderly Teachers at Qinghua University, Beijing University, Beijing Aviation and Aerospace University, Beijing Posts and Telecommunications College, Beijing Science and Technology University, and Beijing Science and Engineering University in the Year 2000

senior and mid-level specialized technical professions is also very prominent. Statistics show that the average age of senior professional personnel for the CAS as a whole is over 53 years. The average age of research personnel is over 55 years, the average age of research personnel in some older institutes is nearly 60 years, and the average age of research assistants is now 55 years. The average age of mid-level professional personnel in the CAS as a whole is now over 44 years, and the average age of research assistants is about 50 in some old institutes.[2]

Faults and aging in S&T staffs are major questions facing S&T policy and management workers that must be acknowledged and countermeasures should be found. Otherwise, it will be hard to fight an enduring battle against key high technology problems by relying on S&T staffs with their former age structures.

Here, we should provide some more detailed analysis using an age of 39 years in the Shenyang Branch as an example.

Shenyang is a trial point city for reform of China's S&T system and an area where high technology and personnel converge. In the past, the Shenyang Branch contributed to China's first atomic bomb, first rocket, first satellite, first nuclear-powered submarine, electron-positron collider, underwater robots, and other major projects. Its present personnel situation is troubling.

The six institutes and one plant in the Shenyang Branch now have 5,436 employees and 3,859 S&T personnel. The ratio between senior personnel and mid-level and low-level personnel is 1:3.42. They are mainly involved in scientific research, development, and production in the three main disciplines of technical science, chemistry, and biology. A chief specialist on "artificial intelligence and robots," one of the seven realms in the "863 Plan," is Jiang Xinsong [5592 2450 2646], director and researcher in the Shenyang Automation Institute.[3]

In the past few years, the Shenyang Branch has established three national-level open laboratories, three academy-level open laboratories, and two post-doctorate circulation stations which have advanced experimental equipment. There are 81 renowned Chinese and foreign scientists who work there (17 from foreign countries and 64 from China) and there are 53 people from foreign countries and 153 people from China doing temporary work in the open laboratories. Seven post-doctoral people work at the Large Chemistry Institute and Metallurgical Institute.

The Shenyang Branch now faces faults which have appeared in its personnel structure. This can be seen from the numbers of undergraduate and graduate students it has absorbed over the years (see Figure 3). There was an obvious reduction in the number of young personnel absorbed during the 15-year period from 1966-1980. Few undergraduate students were absorbed during this period and their professional quality was rather poor. Few key professionals became disciplinary leaders, which created personnel "valleys" and "faults." Now, none of the 128 disciplinary leaders in the Shenyang Branch Academy system is under 35 years old and there is just one person under 45. The remainder are middle-aged and elderly scientists 50 and over. There are just five deputy directors under 35 among the 151 research office directors and only 32 of the 599 study group leaders are under 35. These figures show that a new generation of disciplinary leaders and key scientific research personnel has not taken shape.

One aspect is personnel faults and the other is the risk of weakening reserve forces. Surveys show that the erosion rate of graduate students and undergraduate students in the CAS is rather high. Only about 30 percent are truly contented with their work.[2] Personnel trained by China are serving other people.

These facts tell us that if we fail to take drastic measures, our former personnel advantages will gradually weaken.

Although we have done propaganda on patriotism to reinforce national concepts and education on the meaning of social morality to stabilize popular support, this is just a soft measure for solving the problem. As society has developed up to today, there are limitations

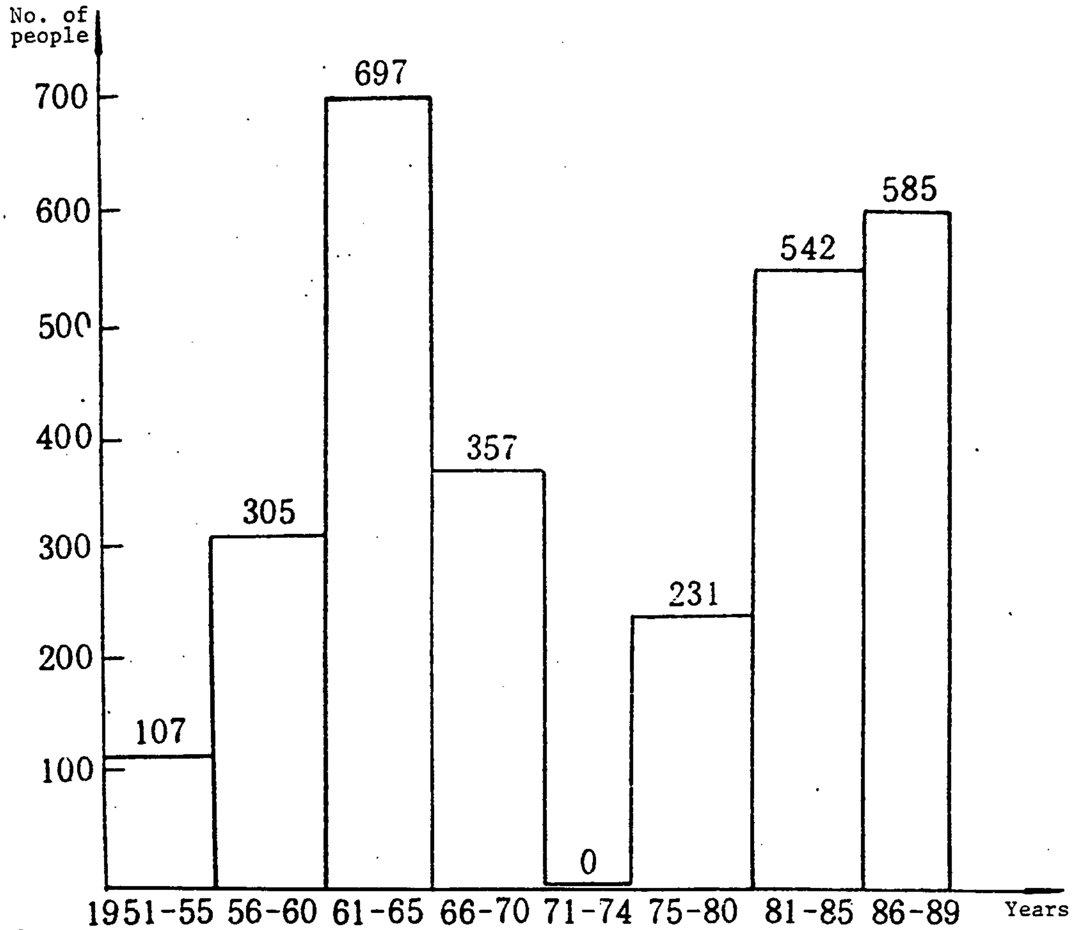

Figure 3. Absorption of Undergraduate Students and Graduate Students in the Shenyang Branch of the CAS Over the Years

to using these soft measures to achieve instant results, so we should look toward hard measures.

The policy measures I have suggested and discussed with others mainly cover these areas:

1. Try to lengthen the scientific lives of S&T personnel trained prior to the "Cultural Revolution" by postponing their retirement. Estimates from the situation shown in Figures 1 to 3 indicate that about one-half should retire by the year 2000. Although they can retire to the second line and even be removed from staff appointments, we can lengthen their job time limits by 5 or more years according to their abilities and health conditions or we can extend everyone in principle by 3 years and then extend some according to concrete conditions for another 2 years. This may weaken and reduce the contradiction between personnel supply and demand.

Things in China now are not like they were following World War II in the 1950's. At that time, young S&T workers dominated most of our S&T staffs and there were few middle-aged scientists. Because we did not have a mature S&T staff like the Soviet Union, it took us 15 to 20 years to catch up with incisive technologies while the Soviet Union took only 4 to 10 years to enter the advanced ranks of the world in the areas of atomic energy and rocket technology. We have this type of staff now and we should take full advantage of their roles. The proportion of people receiving higher education is 57 percent in the United States and even 9 percent in India, but in China the figure is just 1 percent. We must fully exploit the potential and enthusiasm of China's S&T staff.

2. Formulate personnel training plans, select superior quality young personnel in a planned manner, and increase their degree of notoriety, especially cream of the crop personnel. We should establish our own training, look for them in universities, and seek them out at basic levels. Personnel work should be included in long-term development plans in all research organs. In using them, inspect their work achievements and examine their ethical qualities to promote and reward them to systematize and normalize personnel work.

3. Adopt firm measures to get personnel to return who have made achievements while studying abroad and have high levels and substantial influence and who can play a role in their posts. Create the conditions for them in job titles, treatment, housing, scientific research funds, and other areas. We can also implement integrated Chinese and foreign bidirectional training, directional training, and other auxiliary methods to gather personnel together via many channels.

4. For training and selecting young personnel, we should adopt measures like establishing youth S&T research offices and youth S&T associations, establish youth science funds, youth S&T awards, and so on to help China find successors for the cause of S&T.

5. Although we began adopting measures to "mend the fold after a sheep is lost" in 1990, this is far from adequate. We can keep the bodies of young people for a few years but this does not mean that we keep their wavering hearts. Moreover, a few years later is precisely the golden years of their work. Because we cannot hope to use high wages and living standards like the developed nations to win over people's hearts, we must adopt something similar to protectionist trade policies like several nations. We must employ somewhat selective restrictions concerning going abroad to protect the talented personnel of our own country and prevent their blind outflow. We also should carry out international coordination with countries that solicit or rope in talented personnel and use international agreements to restrict the enormous attractive force or plunder-like buying of skilled personnel from developing nations, or we should at least make them create opportunities for skilled personnel from other nations to serve their motherlands or implement certain types of international personnel exchanges of mutual benefit. We cannot allow the phenomenon of the development of poor nations being slowed while the rich nations become even richer to continue to develop. An equal international situation should make world peace even easier than a society with wide gaps between rich and poor.

Personnel faults are an objective phenomenon and it will be hard to reverse our personnel problems in the short run. We may be able, however, to use firm buffer-type measures over the next 10 years to reduce the possibility of the danger of a shock to China's economy and S&T in the year 2000 from a shortage of personnel.

References

1. The Zhongguancun High Technology Region Study Group composed of the Beijing Municipal Scientific and Technical Information Institute and other units, BEIJING ZHONGGUANCUN JIANLI GAO JISHU KAIFAQU DE DIAOCHA YU YANJIU [Surveys and Research on Establishing a High Technology Development Zone in Beijing's Zhongguancun], 1987.

2. Wang Fosong [3769 0154 2646], "Creating Young S&T Staffs Cannot Be Delayed," ZHONGGUO KEXUE BAO [JOURNAL OF SCIENCE IN CHINA], 26 January 1990.

3. Wang Xueliang [3769 1331 5328], "A Discussion of the Personnel System in Research Institutes in the Shenyang Branch of the CAS" (Paper presented at the 9th Scientific Research Management Conference in the CAS, February 1990).

Training S&T Personnel To Meet Future Needs

90FE0240A Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 12 No 6, Jun 90 pp 30-31

[Article by Lan Shuchen [5663 2579 5256]: "The New-Tech Revolution and the Training of Defense S&T Personnel"]

[Excerpt] [Passages omitted]

The 4 decades since the founding of the PRC was an era of earth-shaking changes as old China, semi-colonial, semi-feudal, poor, and blank, became socialist new China with the first signs of prosperity. Among the glorious achievements on the various fronts are the considerable progress in S&T. Over the past 4 decades, major S&T achievements emerged in an endless stream, which is most inspiring. Some of the achievements in atomic energy, biological sciences, agricultural science, high-energy physics, computer technology, rocket carrier technology, and satellite communications technology have approached or reached advanced world levels. The training of S&T personnel has been developing in tandem and keeping pace with S&T achievements. According to statistics, there were 9.66 million natural S&T personnel in units owned by the whole people by 1988, up 21.7-fold over 1952 when there were only 425,000 such workers. Over the past 4 decades, China's defense buildup has made enormous progress in enhancing the motherland's defense capability, including the prowess of defense S&T. This capability is reflected in the rapid maturation of defense S&T personnel as well as the endless parade of S&T research achievements. All this has laid a solid foundation and created favorable conditions for China's effort to meet the challenge posed by the global new-tech revolution, further intensify the training of defense S&T personnel, and build up our defense in the future.

Faced with the challenge of the global new-tech revolution, how are we to step up the training of defense S&T personnel so as to expedite the modernization of China's defense? As I see it, we may consider the following points.

Plan Long-Term, Make Arrangements in Advance

The fact that education takes time to work determines that we must plan ahead in education. "In making a 100-year plan, start with education." This refers to the

strategic place and fundamental role of education in social and economic development. "It takes 10 years to grow trees, but a 100 to rear people," a reference to the role education plays in preparing qualified personnel for economic and social development in the future. It shows the dialectical relationship between the time lag of educational pay-offs and the need for advance planning in education and sums up the law and characteristics of education as a social phenomenon. Defense education too combines the delayed nature of educational payoffs and the need for advance education planning. This is precisely why we must plan long-term and make arrangements in advance in the training of defense S&T personnel, gear up for the last decade of the present century, even the 21st century, forecast the trends and characteristics of international S&T development, draw up a plan for the training of defense S&T personnel accordingly and implement it. Certainly, as we plan long-term and make arrangements in advance, we must take pains to proceed from China's national conditions and integrate what is necessary with what is possible. All practices that ignore the national conditions and are divorced from reality will not do any good. "More haste, less speed." We have learned a profound lesson here. On the other hand, it is a matter of strategy that we should set our sights on the future, understand the situation clearly, make a realistic appraisal, plan our work scientifically, and think comprehensively and long-term. Otherwise, the gap between China and other nations in the world in S&T, particularly high-tech, will become wider and wider, with unthinkable consequences.

Tap Talent Early and Concentrate On Nurturing It

The law of development of S&T personnel shows that people in their 20's and 30's are most likely to make breakthroughs and come up with achievements. This is also true for the growth of defense S&T personnel. That is to say, we must act in accordance with the law of growth of S&T personnel. To begin with, it applies to the entire human society. The increase in knowledge has made S&T more and more difficult, whereas our time of learning is limited. As far as the training of S&T personnel is concerned, therefore, the need to make the corps of S&T personnel younger has become more pronounced and more urgent than at any time in the past. This is also a practical issue raised by the rapid development of the new-tech revolution in the world. If we tap talent in an early stage and concentrate on nurturing it, we will introduce the individuals to scientific research activities earlier and lay a solid foundation when they are young. Second, it takes time for an individual to understand issues and discover laws for himself, in the course of which he will be subject to constraints from all sides. In scientific research, there are inevitably occasions when we take a roundabout course and have to start from square one. When we tap talent early and concentrate on nurturing it, we make it possible for budding scientists who have not yet established themselves to learn from the guidance of experts and scholars and avoid and minimize taking a wrong turn. Third, S&T research cannot be separated from the furthering and refinement of what one inherits from the past. Many of the research achievements of future generations are derived from those of their ancestors. When we tap talent early and concentrate on nurturing it, we enable the younger generation of S&T workers to better carry forward the scholarship of the older generation and be innovative. The first thing Qian Xuesen [6929 1321 2773], the giant of Chinese science, did upon returning home from the U.S. and assuming and directorship of Institute No 5 of the Ministry of National Defense was to offer a graduate course in guided missiles and teach it himself. Of the 300 people in the institute at the time, over 200 were college graduates newly assigned there by colleges and universities. Not only did Qian Xuesen teach them himself, but he also brought together experts in the field to give instruction. For example, Prof. Zhuang Fenggan [8369 6646 3927], an expert in aerodynamics, was invited to teach "aerodynamics;" Prof. Liang Shou [2733 1343], an aircraft expert, was asked to teach "rocket engine;" and Prof. Zhu Zheng [2612 2973] was asked to teach "guided missiles." This practice played an important role in training China's first generation of guided missile experts. Faced with the challenge of the new-tech revolution, many nations in the world today take great pains to tap talent early and go all out to nurture it. In the Soviet Union and East Germany, for example, college freshmen are required to take part in scientific research to develop their ability to conduct research independently.

Increase Contacts and Promote Exchanges

Modern S&T is an international and highly global enterprise that requires the training of S&T personnel to be oriented toward the world. Increasing contacts between nations, promoting education exchanges, and learning from other people's strengths to make up for one's own weaknesses is an effective approach that one should adopt to face up to the new high-tech revolution and develop China's own S&T. On the other hand, if one practices national isolation and shuts oneself up, indifferent to the spectacular developments in S&T in the world, it will definitely have a highly negative effect on the training of defense S&T personnel. The mere fact that modern S&T is intensely international and highly global and that backwardness and advance is a matter of comparison make it possible to increase international contacts and promote education exchanges with the outside world. Such contacts and exchanges in China's recent history fully prove that we must pay attention to the world, the great lecture room for S&T, and make the most of it to turn out qualified personnel for the nation. In pursuit of the goal of making the nation rich and militarily powerful, China sent more than 40,000 young people to the U.S., Japan, and a number of developed European nations for advanced studies between the Opium War and the May 4 Movement. Many of those students returned to China after completing their studies and took up positions in Fuzhou Shipping School, Tianjin Beiyang Naval Academy, Beiyang Defense

Academy, Baoding Army Officers' School as well as the army and navy, contributing to the development of education and the training of qualified personnel. In the 4 decades since new China was founded, international contacts and foreign exchanges have multiplied. We played host to more than 60,000 foreign students and sent more than 70,000 students abroad to study, of whom over 40,000 have returned home. These contacts and exchanges had a good start back in the early 1950's. Since the 3d Plenum of the 11th CPC Central Committee, reform and the implementation of the open policy have enabled China's education enterprise to continue to move forward in the direction of modernization, geared toward the world and the future. Students who returned to China, including defense S&T personnel, are making their presence felt in China's socialist construction. To further increase international contacts, promote foreign educational exchanges, and go all out to train S&T personnel for defense, we must continuously improve the way we send students abroad as well as the way we receive foreign students in the future. As far as students going abroad are concerned, we must intensify their ideological and political education to firm up their patriotism, national pride and confidence, and faith in socialism; inspire them to travel across the ocean in order to revitalize China and achieve the four modernizations; and encourage them to study diligently. As for students coming here, we also can introduce a number of practical changes. For instance, instead of having one Chinese student instructing one foreign student, as is the case at present, we can have two Chinese students guide one foreign student so that Chinese students can get to learn a foreign language and understand a foreign country without going abroad. This is also more economical. Countries like Japan pay a good deal of attention to this.

Sum Up Experience and Act According to Circumstances

Socialist China has accumulated a wealth of experience in the training and nurturing of defense S&T personnel. On the whole, the situation there is good. China has a very strong army of defense S&T workers. Not only are they the cream of the crop, all specialists in one field or another, but they are also highly experienced, having been tempered through practice. Heroic models on the defense S&T front should be publicized. People should be assigned to interview the models in depth and write up on them for publication in newspapers and magazines so that their deeds would be widely known. The spirit of strengthening the nation must be advocated, which will certainly intensify and accelerate the construction of China's socialist spiritual civilization.

In short, at a time when we are faced with the threatening new-tech revolution, we must be fully prepared mentally so that we can seize the opportunity and take actions to meet the challenge head on. The Chinese nation is a great and ancient nation with a glorious culture. China is a great country that is bursting with talent and constantly striving to improve itself. To safeguard the people's peaceful work and their happy life and preserve world peace and development, we need to and must build up a strong national defense.

Experts Given Important Role in Managing S&T Research

90FE0210C Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 10 Jun 90 p 1

[Article by Wang Jianmin [3769 1017 2404] and Han Yuqi [7281 3768 3825]: "High-Tech Research On The Right Track"]

[Text] Four years into its implementation, China's high-tech research development plan has created the rudiments of a S&T management and operating mechanism characterized mainly by reforms in the fund allocation system and decision-making and management by experts. Spurred by the creation of this operating mechanism, 11 research projects in the five areas of biology, information, automation, energy, and new materials have spawned 886 topics under 101 special topics. Currently 7,100 scientific researchers in 343 units are working on the projects each year. A review by experts has determined that outstanding progress has been made in 125 topics, with some reaching advanced international levels. The vast majority of research topics are proceeding as planned and making smooth progress. Only 11 topics are behind schedule.

China's high-tech planned management operating mechanism has the following major characteristics. The allocation of tasks and funds does not follow geographical or sectorial divisions. Instead, experts are allowed to make the decisions. Where the task goes, so goes the funding. Funds are project-specific. Experts are fully utilized in consulting, evaluation, and guidance and in decision-making and management. They are given duties, responsibilities, and power in hiring, project design, topic allocation, and fund utilization. The competitive mechanisms has been introduced into project implementation and hiring through bidding or selective commissioning. Outstanding personnel are discovered and hired. Young and middle-aged experts are given key positions to lead and direct research work.

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